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# THE NATIONAL GEOGRAPHIC MAGAZINE

AUGUST, 1910

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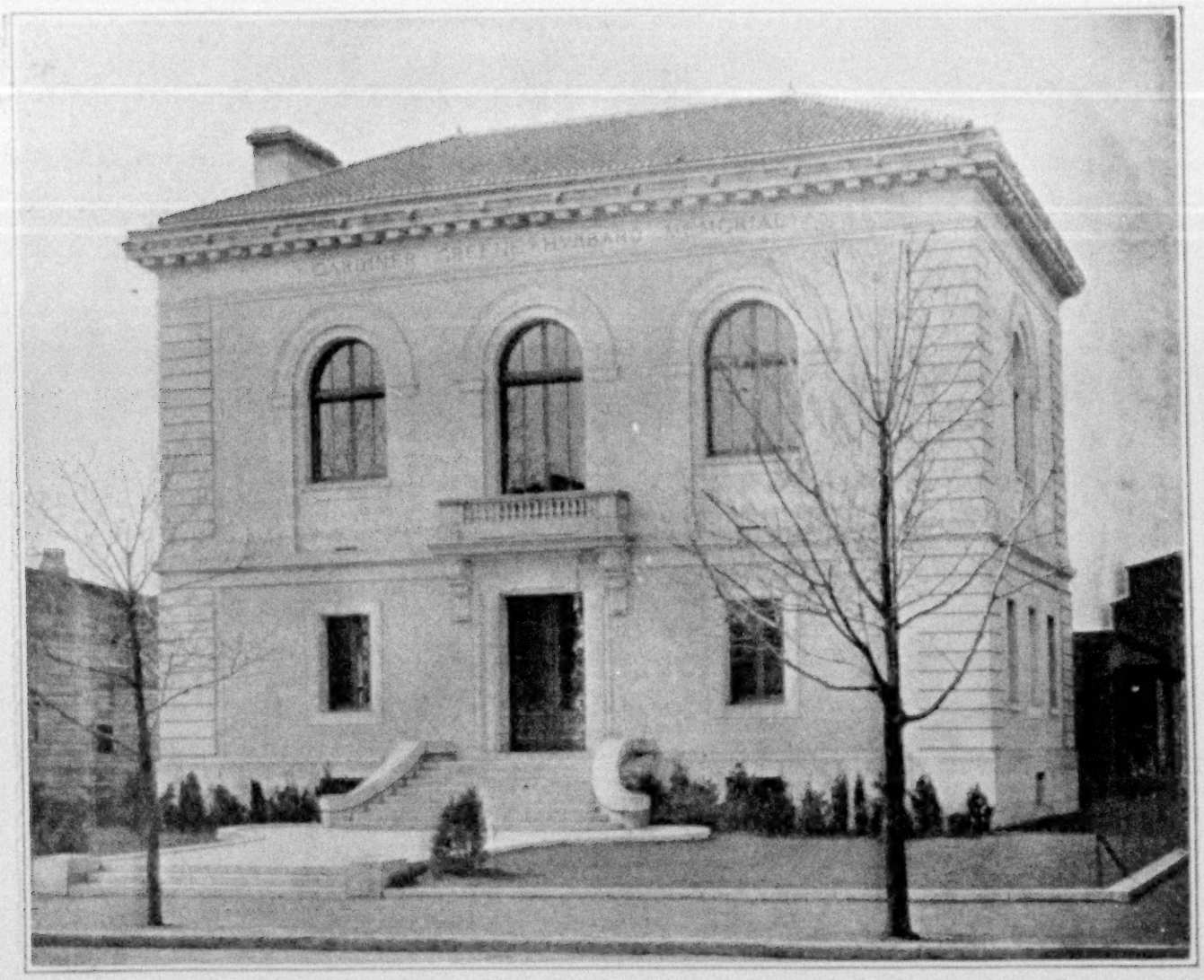

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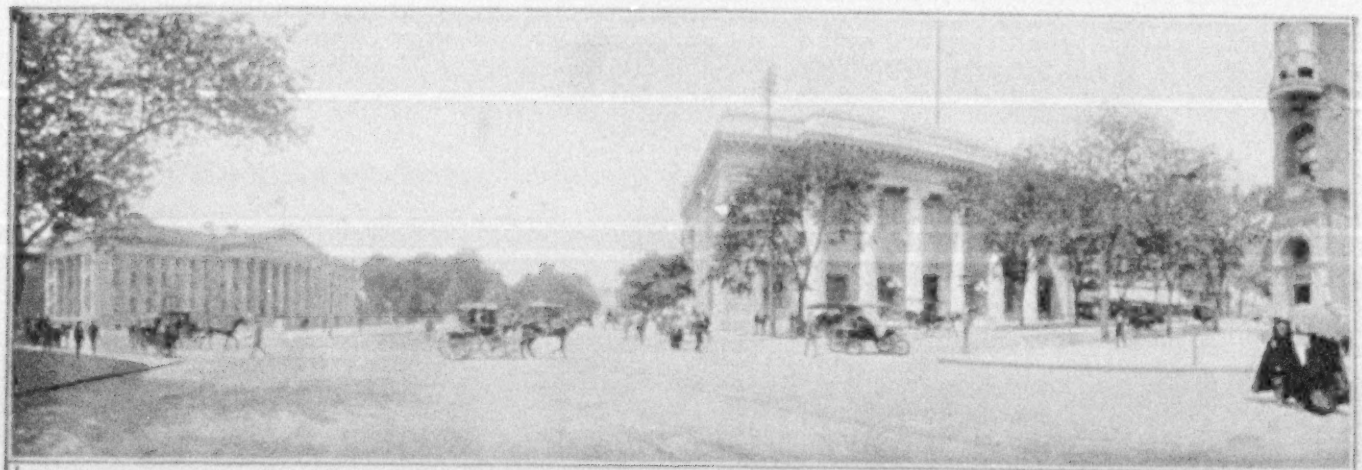

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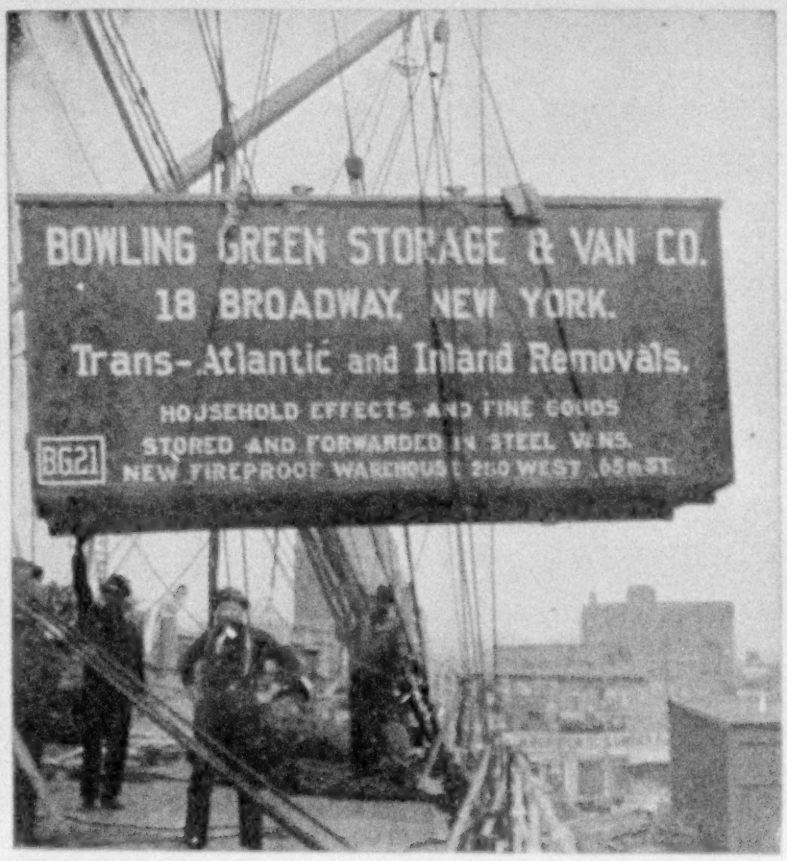


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THE NATIONAL GEOGRAPHIC MAGAZINE

# THE SOUTHWEST

## Its Splendid Natural Resources, Agricultural Wealth, and Scenic Beauty

BY N. H. DARTON, OF THE U. S. GEOLOGICAL SURVEY

THE southwestern section of the United States is a province that presents many special characteristics of physiography, climate, resources, and capabilities which are not as well known as they deserve to be. The term "Southwest" is usually applied to New Mexico, Arizona, and southern California, an area of about the size of New England, New York, Pennsylvania, Maryland, and the Virginias. Much public attention has of late been attracted to Arizona and New Mexico in connection with their admission to statehood, and one gratifying result of this has been a greatly increased interest in their resources and conditions.

Excluding the populous and thrifty coast region of southern California, the Southwest is the most thinly populated and least developed portion of the country south of Alaska. As this condition is due mainly to a climate so arid that but little can be raised without irrigation, its future development is to be measured by the utilization of the vast volume of flood waters now going to waste. This water can be applied to millions of acres of level lands with rich soil, which with the unending sunshine of its mild climate will respond with large and profitable crops.

Unfortunately, there is not enough water for all the land, but there is sufficient, if all were utilized, to support a population many times as large as the present one. The Government is now spending $12,000,000 in reclamation projects in Arizona and New Mexico, which will supply water for nearly one-half million acres of fertile lands. This will give great impetus to development, and in time, when settlers take up the reclaimed land, there will be a large increase in its agricultural productions.

In the great coast region of southern California, with a population of nearly 600,000, the principal product is the orange and other fruits, with a value of about $20,000,000 a year, while in the inland districts the mining industry is the largest source of revenue. Portions of the Southwest are richly productive of various minerals, notably those of copper, and recently southern California has become a heavy producer of petroleum. The value of the copper, oil, and other products of the ground aggregates about $75,000,000 a year.

It is probable that further exploration will disclose large additional supplies of ores of various kinds, especially those of low grade, which will prove profitable under improved methods of reduction.

MAP OF SOUTHWESTERN UNITED STATES

### MOUNTAINS AND RIVERS

As shown in the map (page 632), the Southwest presents a variety of topographic features, and many of its economic resources are closely related to them. There is great range in altitude, with corresponding variation in climatic conditions. One of the most salient features is the wide high plateau of northern Arizona, which reaches an altitude of 8,000 feet. It is surmounted by various volcanic peaks, notably San Francisco Peak, which is 12,611 feet above sea level.

To the east this district merges into an irregular series of high plateaus, constituting the western half of New Mexico.

To the west and south it drops by huge steps into the great region of desert valleys or bolsoms of Nevada, western Arizona, and southeastern California. These deserts are wide long plains, lying between mountain ridges of varying lengths and heights, ridges which are all very rocky and mostly treeless and trend north and south.

Diagonally across southern California there extends the long curving ridge of the Sierra Madre and San Bernardino Mountains, between which and the ocean lies the large oval area known as the valley of southern California. This valley is the great citrus fruit district, and Los Angeles, Riverside, and the many other settlements lie on its gentle seaward slope.

There are two great rivers in the Southwest, the Colorado and the Rio Grande. The Colorado River has been compared to the Nile and the similarity is notable. Both are streams of the first rank, rising in high mountains, and finally crossing a broad region of semitropical, nearly rainless deserts. Both empty into seas in nearly the same latitude, and their lower courses are through wide deltas of fertile soil. The annual overflows add new sediments fertile with plant food and at a time favorable for the crops.

The agricultural capabilities are closely similar, but while much of the lower Nile Valley is utilized the Colorado Valley is just beginning to be settled. The watershed area of the Colorado, with its two head branches, the Green and the Grand, is over 200,000 square miles, its course 2,000 miles in length, and its annual discharge is 11,000,000 acre feet, or enough to cover that number of acres one foot deep.

The sediment which it carries each year into the gulf is estimated to be sufficient to cover 53 square miles one foot deep. For 200 miles of its course across the high plateau of northeastern Arizona it cuts the wonderful Grand Canyon, which in places is nearly a mile deep. South of the canyon it flows mostly in broad valleys, but cuts through several desert ridges, finally passing out into the wide delta plain extending to its mouth.

The Rio Grande is a large river rising in the mountains of Colorado, traversing New Mexico from north to south, and finally constituting the boundary line between Texas and Mexico. Its volume in central New Mexico varies from 200,000 to over 2,000,000 acre feet a year, with an average probably near 1,000,000.

### THE DESERTS

The definition of a desert given by the dictionaries, "a dry sandy region without vegetation or inhabitants," is defective, and the idea that it is necessarily flat is erroneous. Most portions of the average desert bear an extensive, though somewhat widely spaced, flora. Many desert regions contain numerous settlements, the Sahara Desert for instance having a population of 2,500,000. Loose sand is a minor feature, and much more prevalent on the seacoasts and along the bottom lands of rivers. There are wide areas of bare rocks, and the larger deserts include mountains, ridges, mesas, and deep canyons.

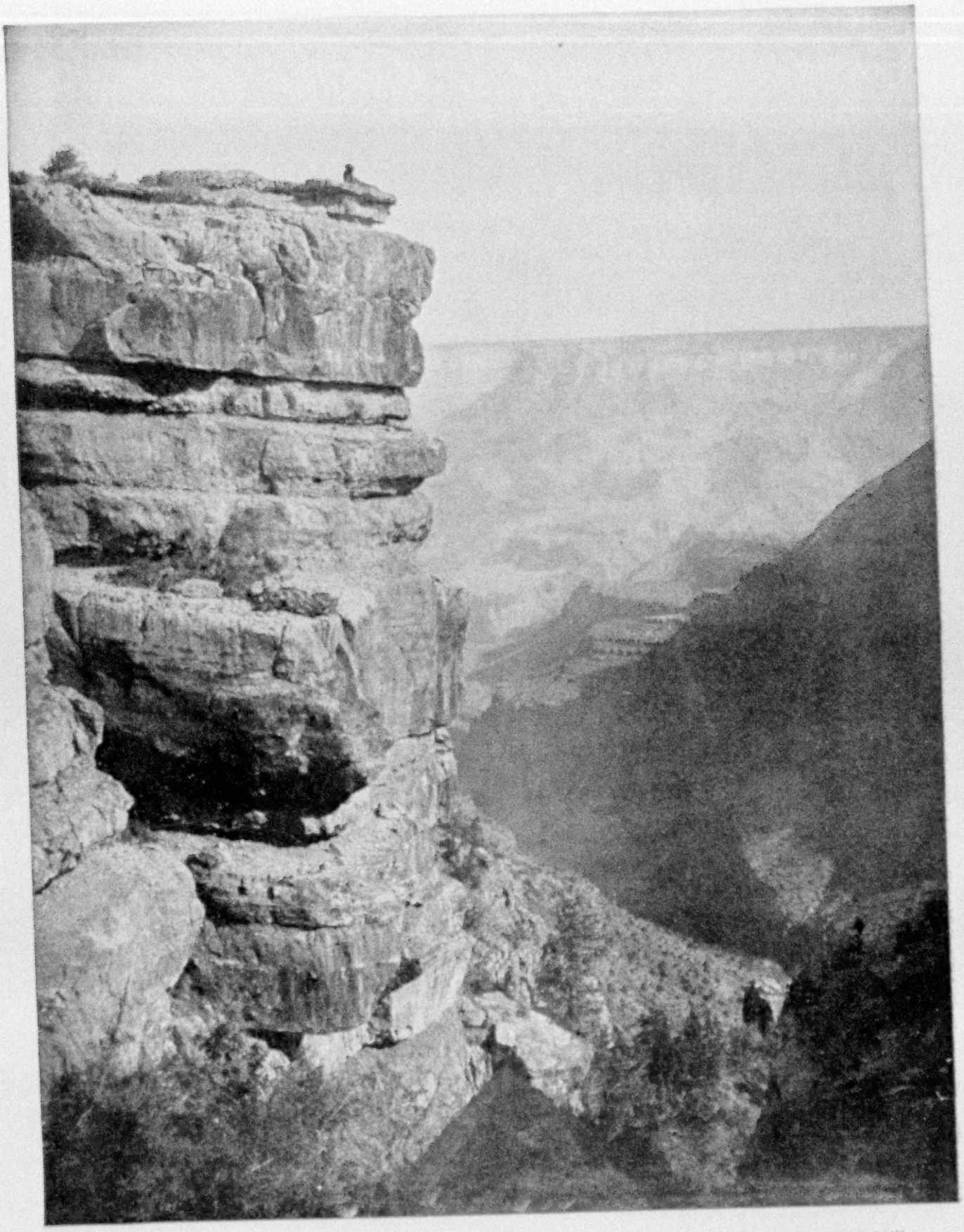
The deserts of the Southwest are regions of very scanty rainfall, parts of them having only three inches a year and evaporation of eighty inches or more. Most of the rain descends in very heavy local storms which give rise to short-lived torrents, sometimes of great volume.

I have witnessed such storms, in some

Photo by J. K. Hillers

GRAND CANYON OF THE COLORADO AT THE JUNCTION OF THE LITTLE COLORADO, LOOKING EAST TO SHINIMO ALTAR: ARIZONA

The river flows 4,000 feet below the plateau



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GRAND CANYON OF THE COLORADO, NEAR THE HANCE TRAIL

Depth, about 4,000 feet, looking east

cases far in the distance, and as a result seen a dry wash suddenly fill with a stream 20 feet deep advancing in successive high waves. The flow would last a few hours, rapidly subside, and perhaps the wash would not be a water course again for several years.

The several large rivers that flow across deserts of the southwest accumulate their waters from melting snows and heavy rainfall in distant high mountains.

The temperatures in the deserts of the Southwest rise high in midsummer, often attaining 125 degrees in the lower lands of Death Valley and the lower Colorado Valley.

The desert vegetation is always a source of interest to the traveler, especially the varied and conspicuous cactus flora. The Saguaro (*Cereus giganteum*) of central and southern Arizona (page 651) is one of the most notable forms. It lives in areas where the precipitation is only three or four inches a year, but is restricted to the warmer districts. It has wonderful capacity for rapid absorption of a large amount of moisture, whether from a heavy downpour or a slight dampening.

The biznaga (*Echinocactus emori*), also known as watermelon or barrel cactus, is an associate of the Saguaro, and I can add my testimony to its usefulness as a most important water bearer. By cutting off its top and beating up the pulp with a stick one can secure a draft of watery juice of fair flavor which will effectively quench the desert thirst.

I once spent the month of November in the deserts of southeastern California investigating artesian waters for the Santa Fé Railroad, and the experience was one of the most delightful of my life. The climatic conditions were perfect, and the region was full of novel features of geology, flora, physiography and scenery which kept me greatly interested throughout the trip.

One must live awhile in the desert to realize its many charms. The brilliant sunsets are especially impressive, and the glowing twilights followed by marvelous effects of light and shade at nightfall piles great velvety shadows along the slopes of the mountains.

The Southwest, however, is rich in features that interest even the most casual observer. The most notable is the Grand Canyon of the Colorado, which is in many ways the greatest natural wonder in the world.

## THE GRAND CANYON

This canyon is the mile-deep gorge cut by the Colorado River across the high plateau of northern Arizona. The view from the rim reveals the most stupendous panorama imaginable, for one sees into an area of about 600 square miles filled with an endless variety of most rugged topographic forms of many beautiful colors. On the sky-line, 10 to 15 miles away, is the edge of a wide-reaching plateau, and in the middle ground of the picture flows the Colorado River, nearly a mile below one's feet.

The features are so gigantic and so plainly in view that all sense of scale is lost, and it is not until one has been down to the bottom of the canyon at the river level that any adequate sense of proportion can be gained.

It is not a smooth-walled canyon of simple type, for, instead, the descent is by a succession of great cliffs and long, steep slopes, and the walls are an alternation of deep recesses and far-reaching promontories. Some of the latter are several miles long, and broken into irregular buttes of many forms.

The canyon is a most superb illustration of direct erosion, for the primary agency in its formation has been flowing water. The movement of talus down slopes, the action of frost, and the sculpturing by wind-blown sand have had an influence in the final details. Certain differential earth movements—faults and flexing—have also caused some modifications of contour. The configuration of the features in the canyon are closely related to rock texture; the great cliffs, many of them 600 feet high, and the plateau, are due to nearly horizontal limestones and sandstones of very mass-

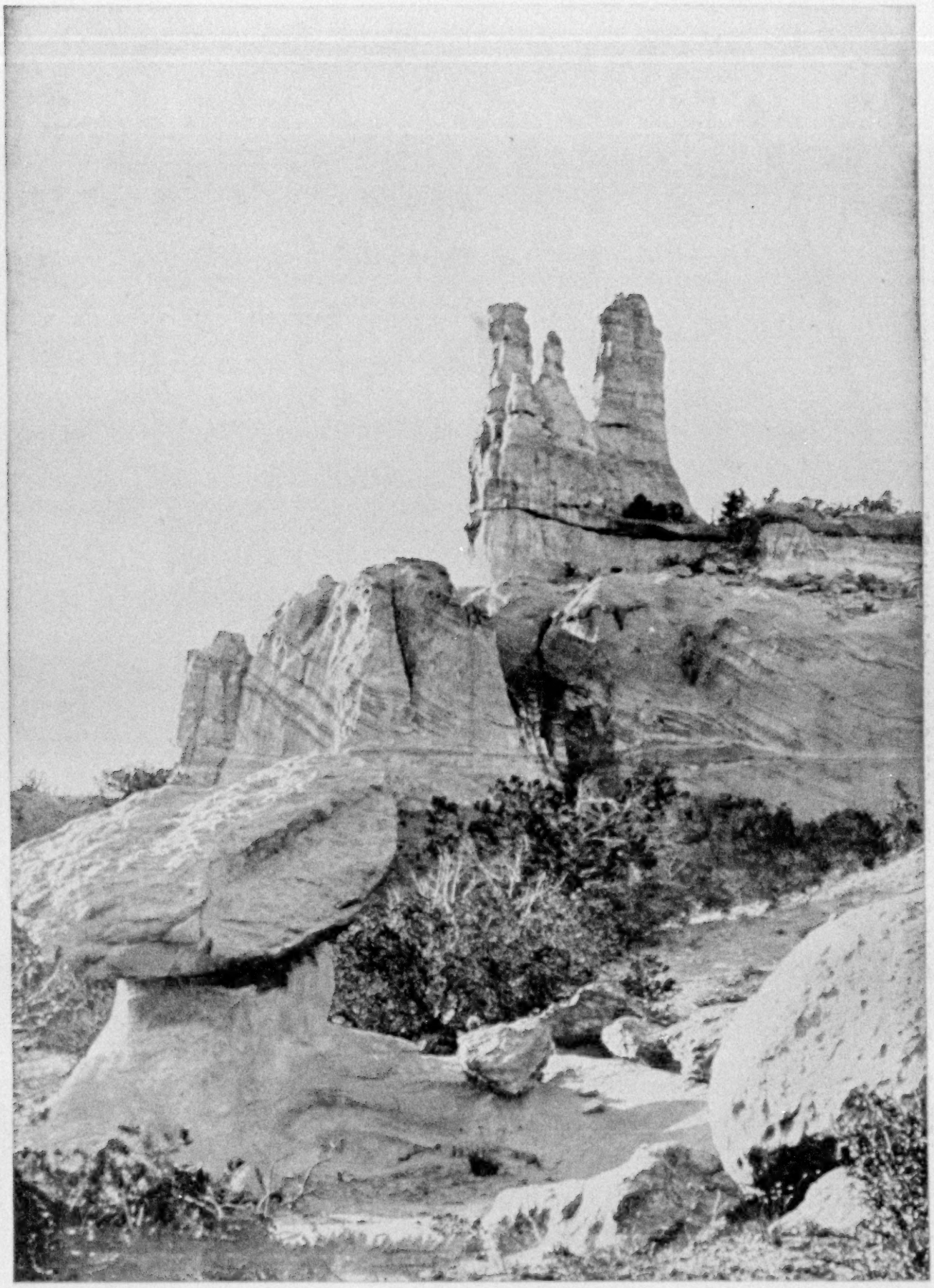
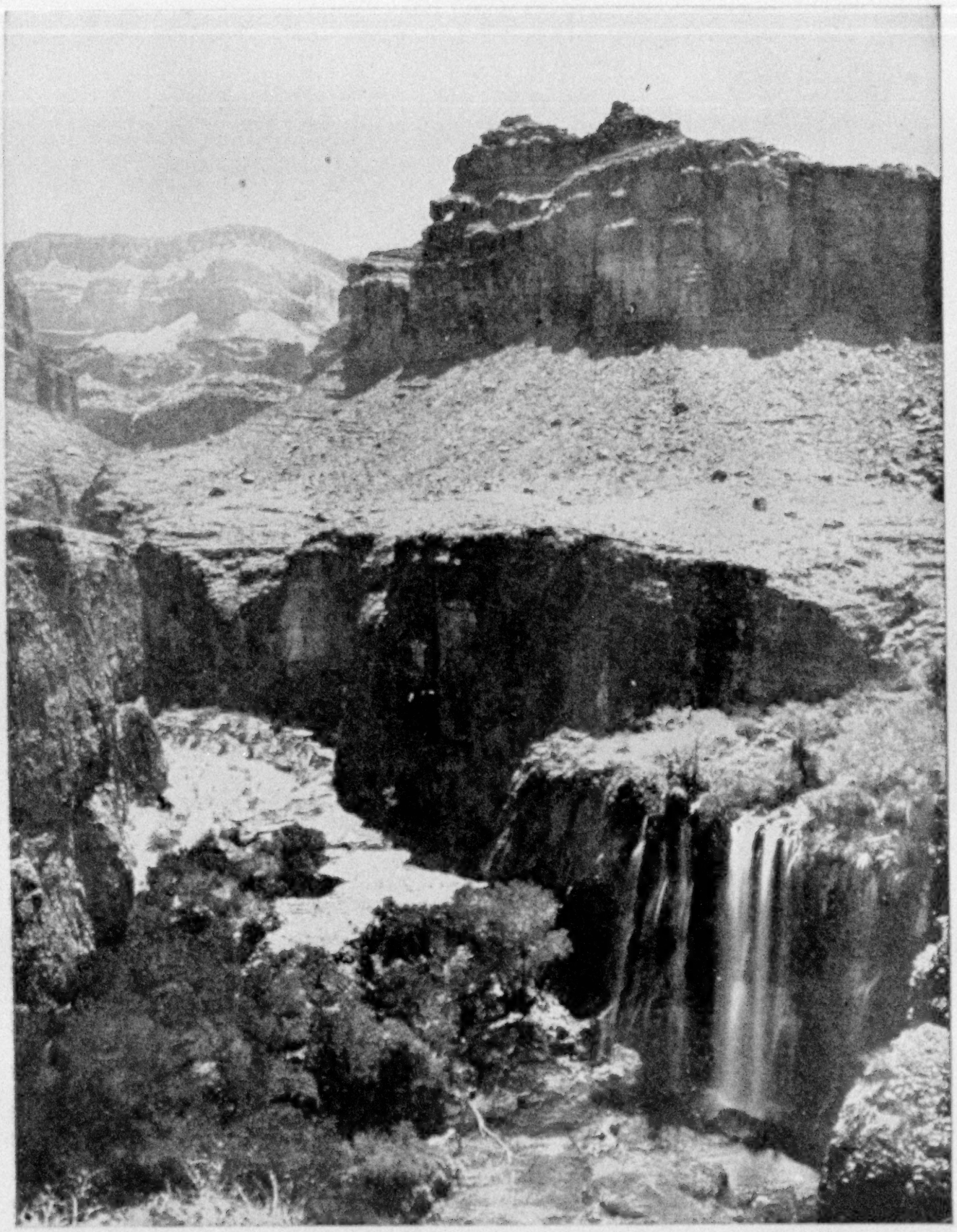


Photo by J. K. Hillers

NAVAJO CHURCH, A PRODUCT OF EROSION IN CROSS-BEDDED GRAY SANDSTONE, EAST OF GALLUP, IN WESTERN NEW MEXICO



NAVAJO FALLS, ON CATARACT CREEK, IN HEART OF GRAND CANYON REGION: ARIZONA

The cliff to the left is about one-half mile high

ive character, while the slopes are mostly of shale and talus. The inner V-shaped gorge, 1,000 to 1,200 feet deep, in which the river now flows, is eroded in granitic rocks. The succession of strata presented in the canyon walls near El Toval Hotel is as follows:

Kaibab limestone.—Light-colored limestone, cherty in upper part, 700 feet.

Coconino sandstone.—Gray massive cross-bedded sandstone, 300 feet.

Supai formation.—Red shale and red slabby sandstone, 1,100 feet.

Redwall limestone.—Very massive gray limestone, mostly red on surface, 550 feet.

Tonto formation.—Slabby sandstones and greenish shales on massive basal sandstone, 700 feet.

The basal sandstone of the Tonto lies on granite and gneiss, of which over 1,000 feet are exposed, but locally on the opposite side of the canyon the Tonto is underlain by a mass several thousand feet thick, of Unkar formation, consisting of red sandstone, limestone, and basalt of Algonkian age.

The rim of the canyon near the hotel El Tovar has an elevation of 6,866 feet, and on the river bank below there is a U. S. Geological Survey bench mark reading 2,436, a drop of 4,430 feet. The river appears like a silvery thread when viewed from the rim of the canyon, but on going to the bottom of the granite gorge the river is found to be 250 feet wide, 20 to 30 feet deep, dashing along with a declivity of about 13 feet to the mile, and in places broken by strong rapids. One can then appreciate the heroism of Major Powell's famous trip down the river in 1869—a thousand-mile voyage in small boats through the entire length of this then unexplored canyon.

The canyon was discovered by Cardenas, who went to its edge in 1540 on a branch trip from Coronado's expedition, on information obtained by Tovar from the Hopi Indians. The original name given to the river was Tison, Spanish for firebrand, and it is to be regretted that the name has not been retained to avoid the present confusion due to the river having the same name as the state.

Formerly to reach the Grand Canyon it was necessary to stage 60 miles across the plateau, but now there is a branch from the Santa Fé railroad at Williams which takes the tourist to the fine hotel El Tovar, built on the brink of the canyon at one of the best view points.

### SOME NATURAL WONDERS

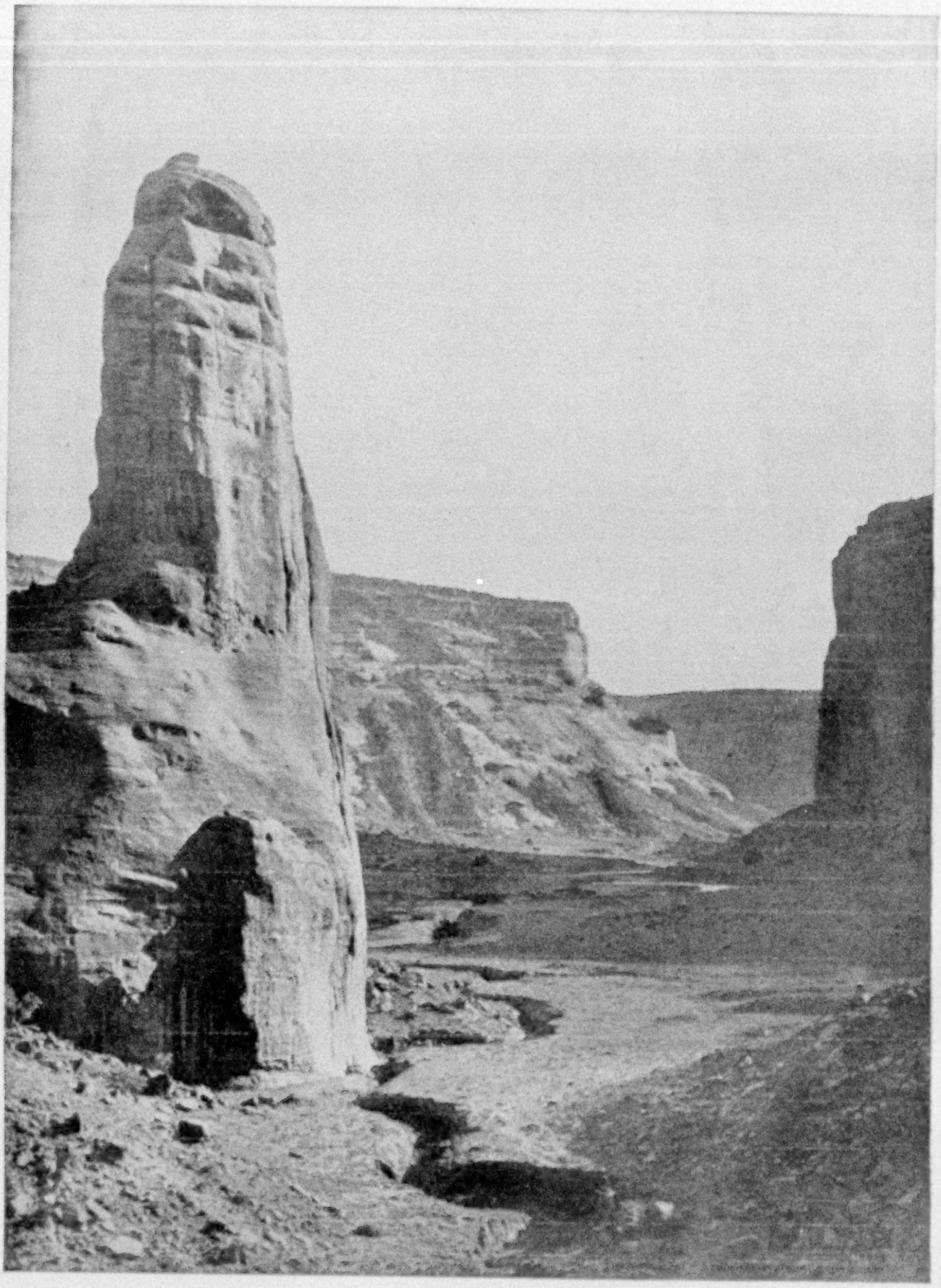
Coon Butte, another of the greatest wonders in our country, is also situated in the Southwest, but owing to its distance from the railroad it is seldom visited. It is a great crater-like bowl in the plateau, about 10 miles south of Canyon Diablo station. The "crater" is about 4,000 feet wide and 600 feet deep, with an irregular encircling rim of loose rock fragments from 120 to 160 feet high. The wall of the depression shows broken-off edges of sandstones and limestones considerably upturned, and the rim consists of the ejected material. Some have advanced the theory that the features are due to the impact of a huge meteor, and a mining company has spent large sums drilling holes to find the iron or other meteoric material, but without success. Mr Gilbert's suggestion that the cause was a great volcanic steam eruption is much more plausible, however, for there are numerous volcanic vents at no great distance.

The petrified forests attract many visitors, especially the most accessible one south of Adamana, a station on the Santa Fé railroad a few miles east of Holbrook. There is a large quantity of the material in sight here, some of it in large logs. One of these logs spans a small draw as a natural bridge.

Arizona possesses a very picturesque natural bridge of limestone spanning Pine Creek, in Gila County, 70 miles south of Flagstaff. It does not, however, rival the great bridges recently discovered in Utah. Its span is 80 feet, its height about 125 feet, and its length up and down the creek is over 400 feet.*

Canyon de Chelly is one of the most notable scenic features in Arizona (see

* See "The Great Natural Bridges of Utah." By Byron Cummings, pp. 157-167, NAT. GEOG. MAG., February, 1910.



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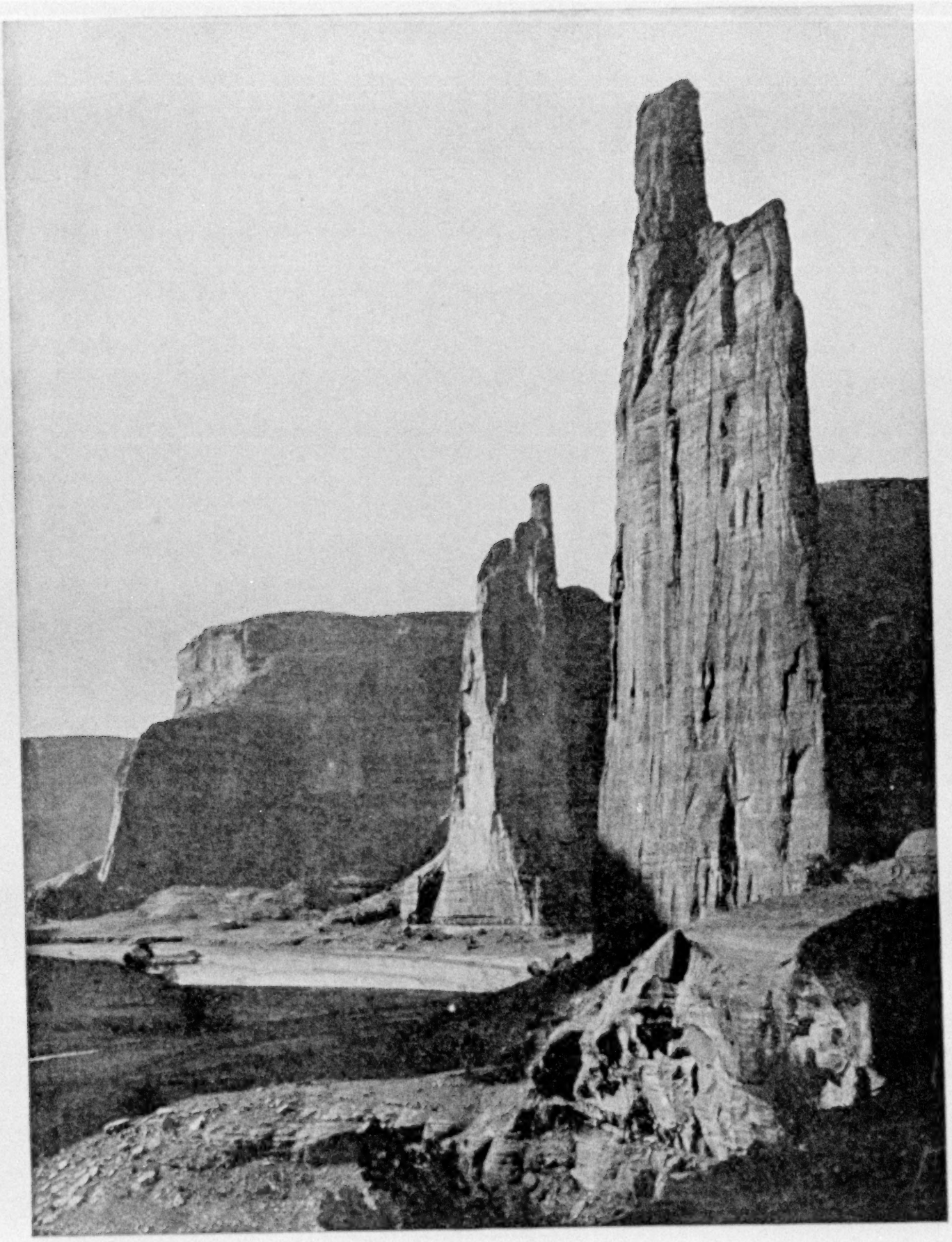
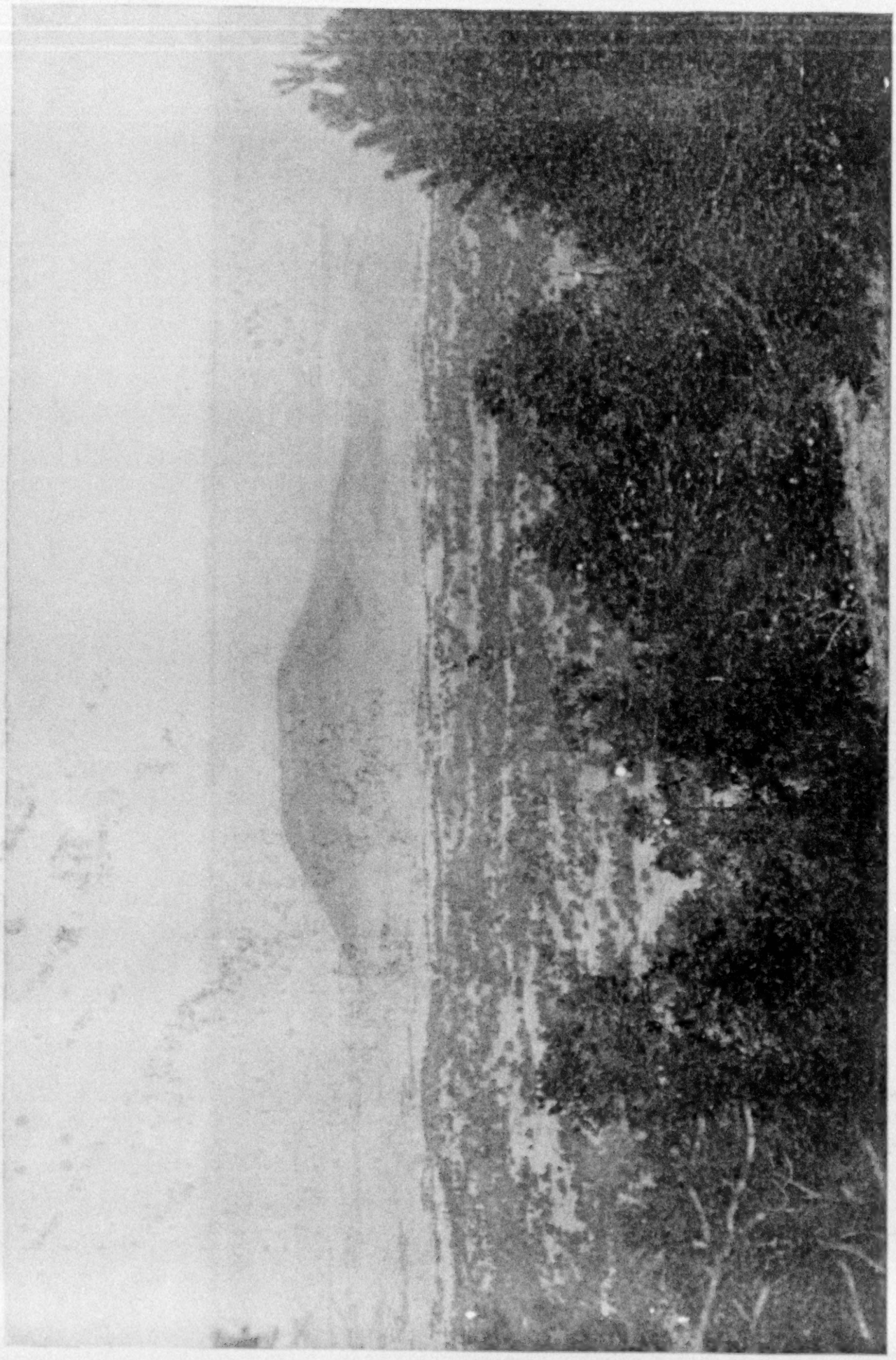
CLIFFS AND PINNACLES OF RED SANDSTONE IN CANYON DE CHELLY, NORTHEASTERN ARIZONA

Note the man at foot of high pinnacle



CAPTAINS OF THE CANYON: 600-FOOT CLIFFS AND PINNACLES OF RED SANDSTONE IN CANYON DE CHELLY, NORTHEASTERN ARIZONA (SEE PAGE 639)



A CINDER CONE NEAR SAN FRANCISCO MOUNTAIN Photo by G. K. Gilbert

The product of very recent volcanic outbursts, rising over 200 feet, and just as fresh as if made yesterday

page 640), but it is so far off the main line of travel that it is rarely visited. It is cut deeply into soft sandstones, which rise in vertical walls, with many outlying pinnacles and monuments. Some of these features appear also in the great wall of red sandstone on the north side of the wide depression through which the Santa Fé railroad crosses the continental divide east of Gallup. One of the most remarkable pinnacles of this wall is fancifully termed the Navajo Church, shown on page 637.

### THE FORESTS

Few persons who travel across the Southwest realize that in Arizona and New Mexico there are enormous forests of valuable timber and that the lumbering is an important industry. In both territories there are several large forest reservations, and one of these in Arizona, the Coconino Forest, with nearly 6,000 square miles, is the largest single reserve in the United States. The total forest area reserved in Arizona is 15,250,130 acres, or more than 24,000 square miles, and in New Mexico there are 10,971,711 acres, or more than 17,000 square miles. Southern California also has several large reserves.

The Coconino Forest in Arizona occupies part of the great plateau in which the Grand Canyon is cut, and extends to the brink of the canyon. It covers a wide area about San Francisco Mountains, and extends southeastward for 200 miles along the south edge of the plateau to New Mexico. Its extension in that territory is known as the Datil and Gila reserves, comprising 4,652,450 acres, the largest reserved area in the country. There are other large reserves in various portions of both territories.

The principal tree in these forests is the western yellow pine, and not the white pine, as commonly reported. Its lumber is only of moderate value as compared with high-class woods, but its local importance is very great. The trees grow from 80 to 125 feet high, and many of them 3 feet in diameter. In 1908 this pine constituted 96.5 per cent of the lumber cut in Arizona and 87.7 per cent of the cut in New Mexico.

There is now great interest in the cultivation of Eucalyptus in California, and many large groves have been started as a business enterprise. Several varieties of the tree were introduced many years ago, and most of them show remarkable growth and high value for many purposes. One of the railroad companies has planted about 4,500 acres to raise trees for ties, piling, and other uses. In some cases a tree will attain a height of 100 feet in six years, but some of the more rapid growing varieties have less satisfactory timber than is obtained from those of slower growth. One good feature of the tree is that it will grow on soils that are of but little value for agriculture.*

### THE INDIANS

The visitor to the Southwest usually takes keen interest in the Indians, who are numerous not only along the main lines of travel, but in many remote villages. Some tribes, notably the Apaches, who continued to be troublesome until a relatively recent date, have become famous for the misdeeds that materially retarded the development of Arizona and western New Mexico. Now, however, all is peace and tranquillity. The newspapers, especially Eastern ones, occasionally print accounts of uprisings, but these prove to be local quarrels with a few individuals.

The Indians of the Southwest are of two kinds, differing greatly in most of their characteristics: One is the nomad type, represented by the Apaches, Navajos, the Yumas, Papagos and Pimas, and smaller tribes; the other is the pueblo type, which is comprised in 26 pueblos, or villages, scattered through central and western New Mexico, and in the Hopi Reserve, in northeastern Arizona.

Probably there is greater popular interest in the pueblo people, for their settlements are permanent and mostly very ancient, and their religious ceremonies are extremely elaborate and picturesque.

* See NAT. GEOG. MAG., July, 1909, pp. 668-673.

They live in villages of several hundred inhabitants, in substantial stone or adobe houses, some of which are in groups, rising in tiers to a height of four or five stories, with streets and central plaza. They are peaceful and industrious, raising crops largely by irrigation. They have herds of cattle and sheep, and spinning, weaving, and making their garments is one of their important occupations.

Work appears evenly divided between man and woman in the pueblos. The men do the farming, tend to the cattle and sheep, do the hunting, build the houses, and have many smaller trades and occupations. The women do the housework, grind the corn, make pottery, blankets, and clothes.

The visitor is generally impressed by the pueblo people, and pleased with the agreeable home life and the simple hospitality which they readily offer.

Zuñi is notable in this respect, and although it is far out of the usual line of travel it well repays a visit. The houses are built of adobe—bricks of sun-dried clay—and rise in tiers on the hill slope, as shown on page 652, so that in many cases the roof of one is the front yard of the next. All are provided with windows and doors, and inside there are clean whitewashed walls and fairly high ceilings, supported by long stout logs. The floor is adobe, smooth and clean. At one corner is an open fireplace, but cookstoves are not uncommon. The furniture consists of chairs and board tables, while for beds skins are spread on the floor. At night kerosene lamps give light. One can spend a very pleasant evening in such a home with the bright cheerful Zuñi men and women, and find the conditions quite equal to and even better than the standard of the lower-class ranches of the West.

Many visitors go to the Hopi villages, 75 miles northwest of Holbrook, to witness the snake dance and other ceremonies, and Zuñi, Taos, Acoma, and other pueblos are occasionally visited by the sightseers. Laguna, on the Santa Fé Railroad, a few hours west of Albuquerque, is the best known by sight, for all of it is visible from the train.

The elaborate religious beliefs and observances of the Indians of the Southwest have been the subject of many volumes, and although some of the Christian churches claim a few converts, the simple people of the pueblos prefer to cling to their own ancient traditions.

In earlier days, long prior to the discovery of the continent by Europeans, the Southwest was occupied by a large population of agricultural people, with extensive settlements in many of the valleys. We now find ruins of the villages, traces of their irrigation works, and old hiding places among the cliffs, which throw much light upon their character, occupation, and history.

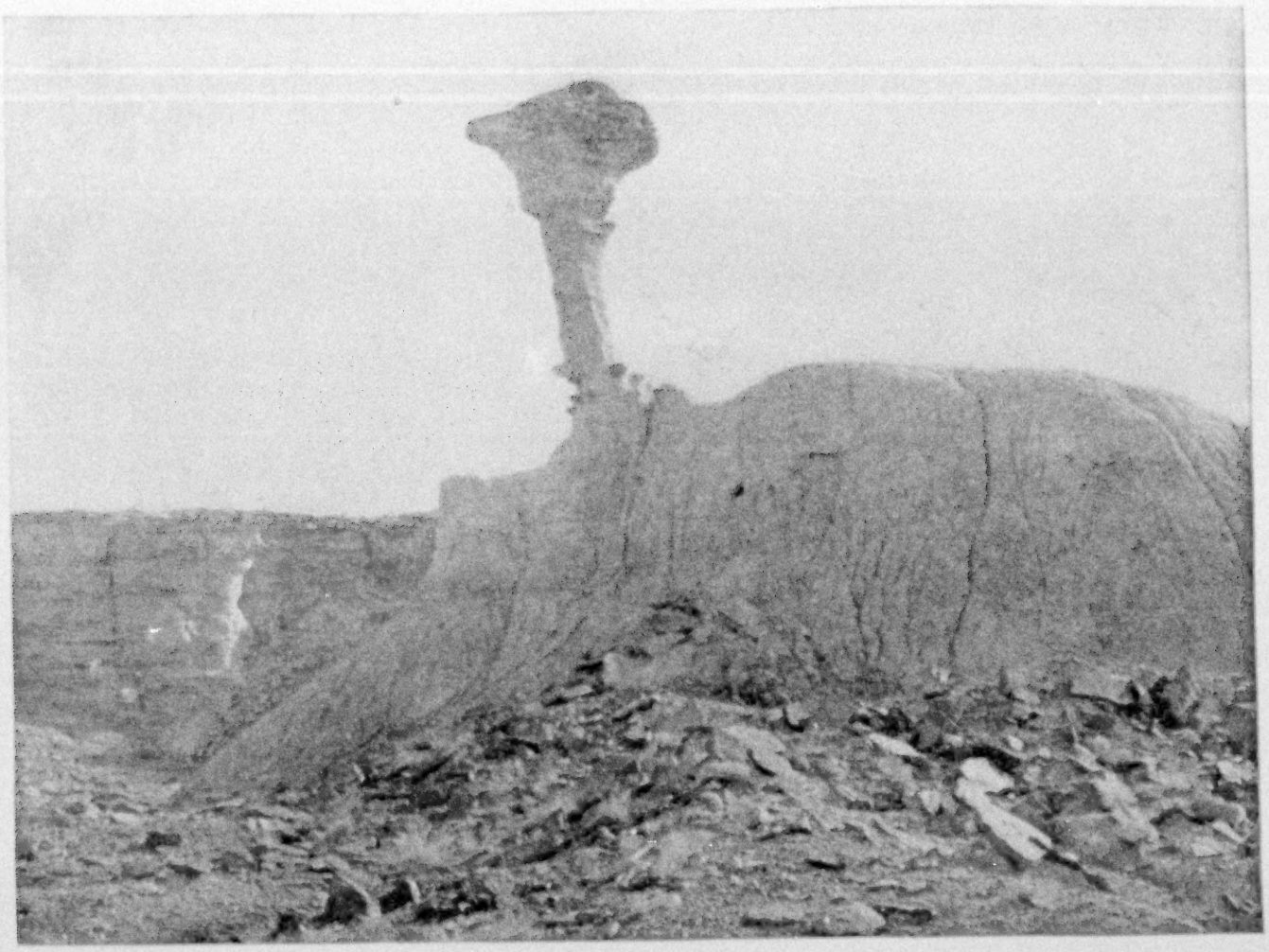
The pueblo people of the present appear to be their descendants, but they are only a handful compared to those of the earlier times. It is evident that they were victims of the predatory Indians from the North, notably the Apaches, and there are many traditions among the surviving tribes of the ruthless warfare which their ancestors suffered.

## TOURISTS

The interesting features of the Southwest, notably the beauty of the coast region and the special climatic advantages, draw a large number of tourists and health-seekers, especially in winter, and every year sees a substantial increase in the influx of visitors.

Southern California is the principal destination, and Los Angeles, Pasadena, and the beach resorts receive a great throng of sightseers. Many of them also go south to San Diego and the nearby Coronado Beach, where the magnificent Del Coronado Hotel delights the visitor. Others content themselves with a visit to Los Angeles and Pasadena and go north through Santa Barbara and other places to San Francisco. Phœnix, Arizona, receives a moderate share, notably of the health-seekers.

The conditions of travel and living in the Southwest are similar to those in most other portions of the West. Two



OSTRICH ROCK: AN EROSION FEATURE IN THE PETRIFIED FOREST OF ARIZONA

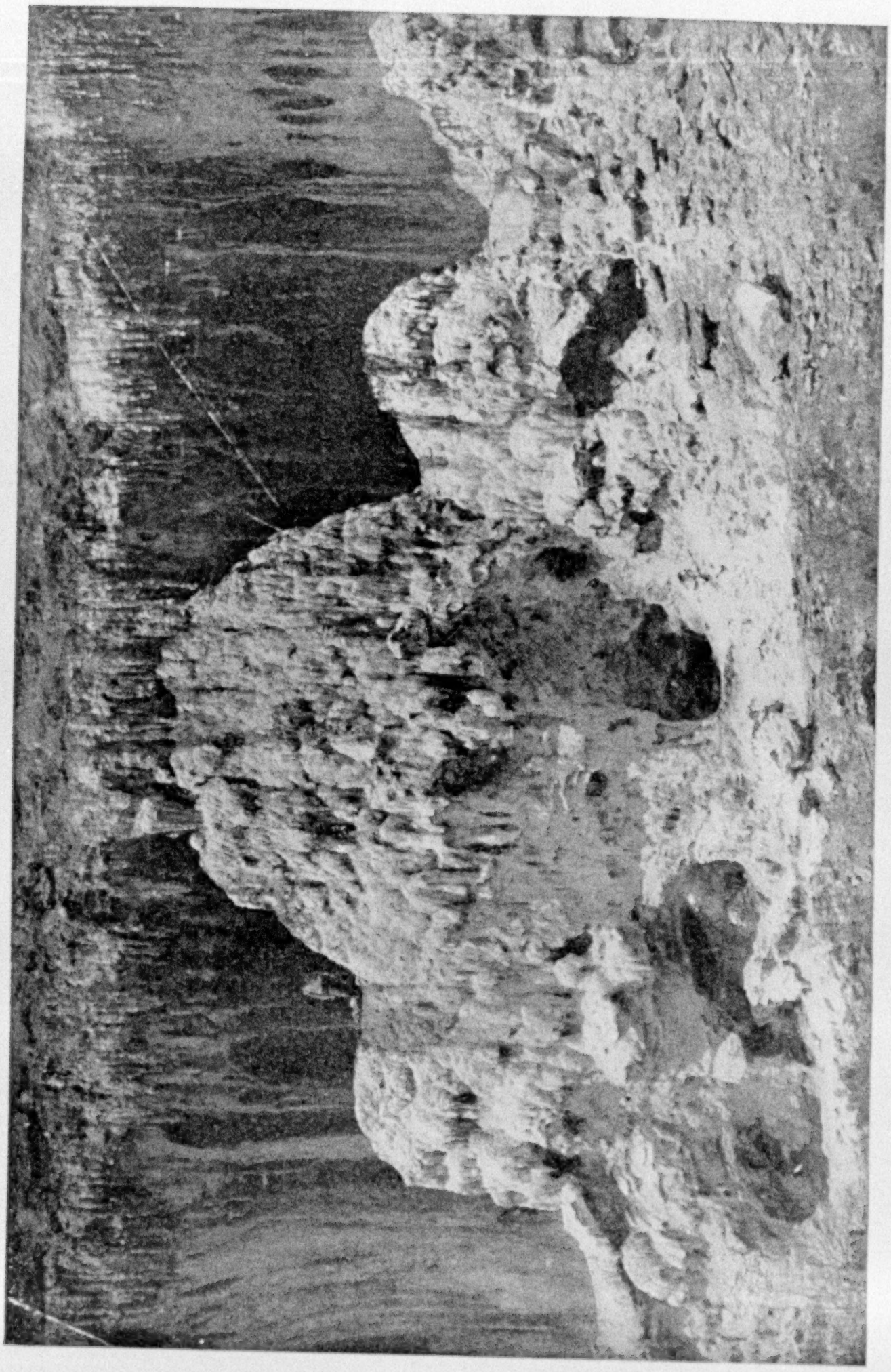
great railroad systems cross the country from east to west—the Santa Fé in the north and the Southern Pacific in the south—with various branch lines in different directions. Hotels are plentiful along the main lines of travel and throughout the valley of southern California, but especially noteworthy are the high-class mission-style hotels of the Harvey system strung along the Santa Fé lines in Arizona and New Mexico.

### THE SOUTHWEST FOR HEALTH

Because of its dry air and mild climate, the Southwest has become famous as a health resort, especially for those having tuberculosis of the respiratory organs. The percentage of cures made in New Mexico, Arizona, and California, great as it is, would be much greater if a larger proportion of those who are seeking health came in time. It is necessary to come before the vitality is too greatly diminished and then to live under favorable conditions, the most essential of which is to be out of doors as much as possible.

"Lungers," as such invalids are termed, are not welcomed in the cities and larger settlements, and some hotels will not receive them, but there are many special resorts, such as tent colonies and sanatoriums for them. In the smaller villages and through the country there is usually no difficulty in securing accommodations.

Unless the affected person has some means to invest in a place of his own he is at considerable disadvantage, for it is difficult to obtain suitable employment. Living expenses are somewhat higher in the Southwest than in the central and eastern states, especially in the larger cities. Very little provision has been made for indigent consumptives, and many sick persons without means suffer great hardship in trying to sustain themselves after coming to the Southwest.



CAVERNS IN THICK DEPOSITS OF PURE ROCK SALT ON BANK OF SALT RIVER, IN MOUNTAINS OF CENTRAL ARIZONA

Note the man in upper left corner

Many health-seekers spend most of their money in railroad fare to reach the desired resorts. Physicians do a great wrong to patients in sending them so far from home, friends, and care without means to provide suitable quarters, nourishment, and attention to sustain them while making their fight against death.

It is found that different climatic conditions have important bearing, some persons deriving greater benefit from the dry cool highlands, while others prefer the lower deserts or the moister seacoast. In most cases the high summer temperature of the lowlands is too debilitating, and it is necessary to go into the highlands for the summer.

The Government has established a marine hospital at Fort Stanton and an army and navy hospital for consumptives at Fort Bayard, both in the highlands of New Mexico.

### CLIMATE

The climate of the Southwest presents considerable variety, but in all the lower lands the winters are delightfully mild, and everywhere blue sky is in evidence for more than 300 days in the year. The summers are warm; in the southern desert area they are decidedly hot for several months, but the dry air even then is much more endurable than the sultry summer weather of the eastern and central states. Sunstroke is unknown, and laborers continue their work without distress.

While the temperature in the deserts of southern California and Arizona often rises to 120 degrees in the shade, if perspiration is sustained by plenty of water, the average person suffers no great inconvenience. Most of the nights are decidedly cool excepting in the lower lands farthest to the south.

The conditions in the deserts are well illustrated by the following table of monthly temperatures and rainfall at four typical desert stations.

On the higher lands of Arizona and New Mexico the summer weather is altogether agreeable, and in southern California west of the mountains the summer temperatures are moderate owing to the sea breezes which are nearly always in motion. The table on page 650 gives the average weather conditions, 1897-1909, at Redlands, California, which is typical of much of the coast region of southern California.

*Temperatures and Rainfall in Desert Regions in the Southwest.*

| | Fort Yuma. | | | Phœnix. | | | Tucson. | | | Mohave. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. temp. | Min. temp. | Mean rainfall. | Max. temp. | Min. temp. | Mean rainfall. | Max. temp. | Min. temp. | Mean rainfall. | Max. temp. | Min. temp. | Mean rainfall. |
| Years observed. | 26 | 26 | 20 | 17 | 17 | 22 | 6 | 6 | 15 | 5 | 5 | 26 |
| | ° | ° | *Inches.* | ° | ° | *Inches.* | ° | ° | *Inches.* | ° | ° | *Inches.* |
| January | 81 | 22 | .42 | 87 | 12 | .80 | 80 | 17 | 79 | 70 | 16 | .95 |
| February | 91 | 25 | .61 | 92 | 19 | .70 | 83 | 17 | .90 | 78 | 20 | .92 |
| March | 100 | 31 | .26 | 97 | 24 | .58 | 92 | 22 | .77 | 83 | 26 | .75 |
| April | 107 | 38 | .07 | 105 | 30 | .30 | 30 | 95 | .28 | 100 | 35 | .17 |
| May | 112 | 44 | .04 | 113 | 35 | .13 | 102 | 32 | .14 | 102 | 38 | .03 |
| June | 117 | 52 | T. | 119 | 33 | .10 | 112 | 48 | .26 | 107 | 48 | .05 |
| July | 118 | 61 | .14 | 116 | 46 | 1.03 | 108 | 59 | 2.40 | 115 | 64 | .08 |
| August | 115 | 60 | .35 | 116 | 49 | .88 | 109 | 57 | 2.60 | 112 | 57 | .04 |
| September | 113 | 50 | .15 | 114 | 39 | .64 | 107 | 49 | 1.16 | 104 | 45 | .07 |
| October | 108 | 41 | .28 | 105 | 34 | .37 | 98 | 29 | .64 | 93 | 40 | .25 |
| November | 92 | 31 | .29 | 97 | 24 | .51 | 90 | 21 | .81 | 84 | 27 | .40 |
| December | 83 | 24 | .46 | 95 | 18 | .86 | 83 | 10 | 1.00 | 70 | 15 | 1.26 |
| Year | 118 | 22 | 2.84* | 119 | 12 | 6.93 | 112 | 10 | 11.74 | 115 | 15 | 4.97 |

* 26 years' observation.

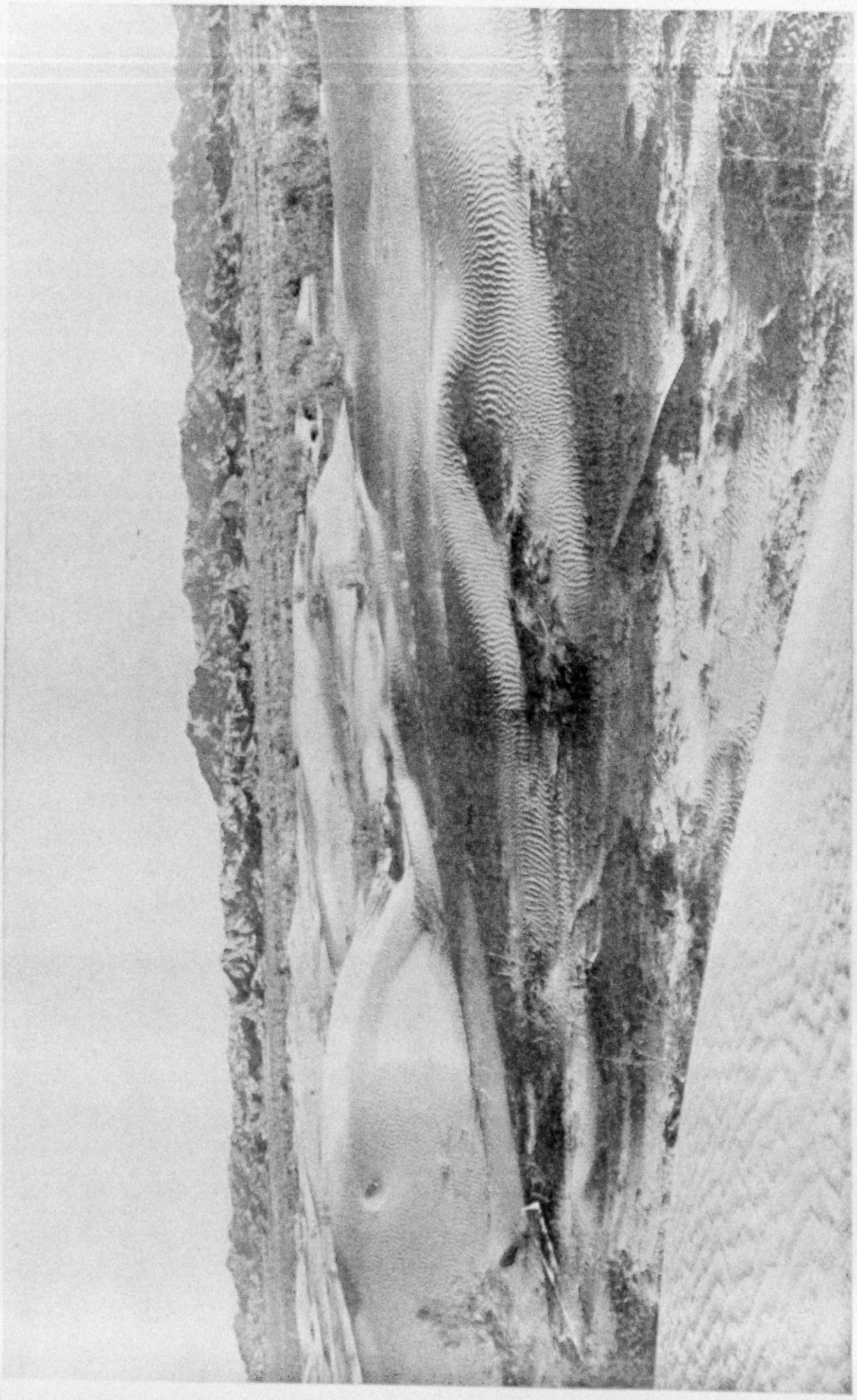
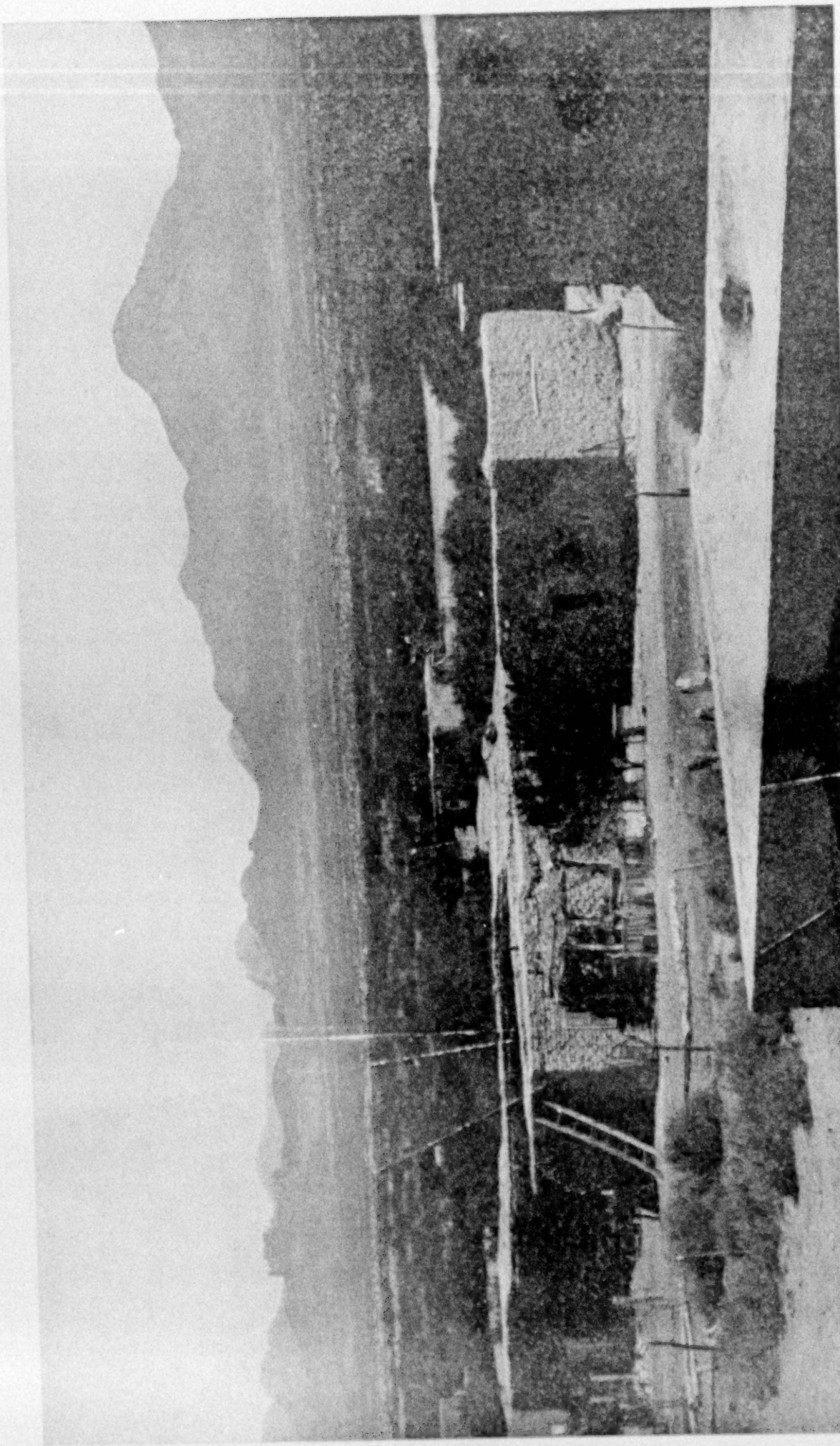


Photo by W. C. Mendenhall

SAND DUNES IN THE COLORADO DESERT OF SOUTHERN CALIFORNIA (SEE PAGE 633)



DONA ANA MOUNTAINS, CENTRAL NEW MEXICO, FROM TOWN OF DONA ANA

Typical Mexican adobe residence in foreground

*Average Weather Conditions at Redlands, California, 1897–1909*

| | Mean humidity. | Mean temperature. Max. | Min. | Daily. | Average rainfall. |
|---|---|---|---|---|---|
| January.... | 43 | 63 | 40 | 52 | 2.64 |
| February... | 48 | 66 | 42 | 54 | 2.37 |
| March..... | 42 | 70 | 43 | 56 | 3.08 |
| April..... | 32 | 74 | 47 | 60 | 1.85 |
| May..... | 44 | 76 | 50 | 63 | 1.76 |
| June..... | 36 | 88 | 54 | 71 | .17 |
| July..... | 26 | 95 | 58 | 77 | .01 |
| August..... | 27 | 95 | 59 | 77 | .16 |
| September.. | 28 | 90 | 56 | 73 | .27 |
| October.... | 33 | 81 | 50 | 66 | .74 |
| November.. | 35 | 72 | 45 | 58 | 1.04 |
| December... | 32 | 67 | 41 | 54 | .95 |
| Total for the year..... | | | | | 15.04 |

Only 16 per cent of the days are cloudy and rainy. The rainy days average but 15 in a year. During all these years the temperature has exceeded 100 degrees in July, August, and September on an average of only fifteen times a year, and has fallen below 32 degrees on an average of less than three times a year. The wet bulb thermometer is usually less than 20 degrees below that of the dry bulb. The lowest recorded temperature of 25 degrees was only reached twice. January, February, and March are the wettest months.

The valley of southern California is protected from the cold northern winds of winter by high mountain ranges, while to the south it is open to the Pacific. Owing to the peculiar configuration of the coast the cold California current from the north is deflected west near Point Conception, and hence the southern California shores have waters warmer by about 10 degrees than those to the north. Then, too, the mountain barriers afford protection from the heat of the dry hot deserts to the east, and they cause precipitation which affords running water in fair volume in many streams. These mountains are so high that the winter snows linger on them far into the spring, when southern California is gay with its innumerable flowers.

FRUIT OF SOUTHERN CALIFORNIA

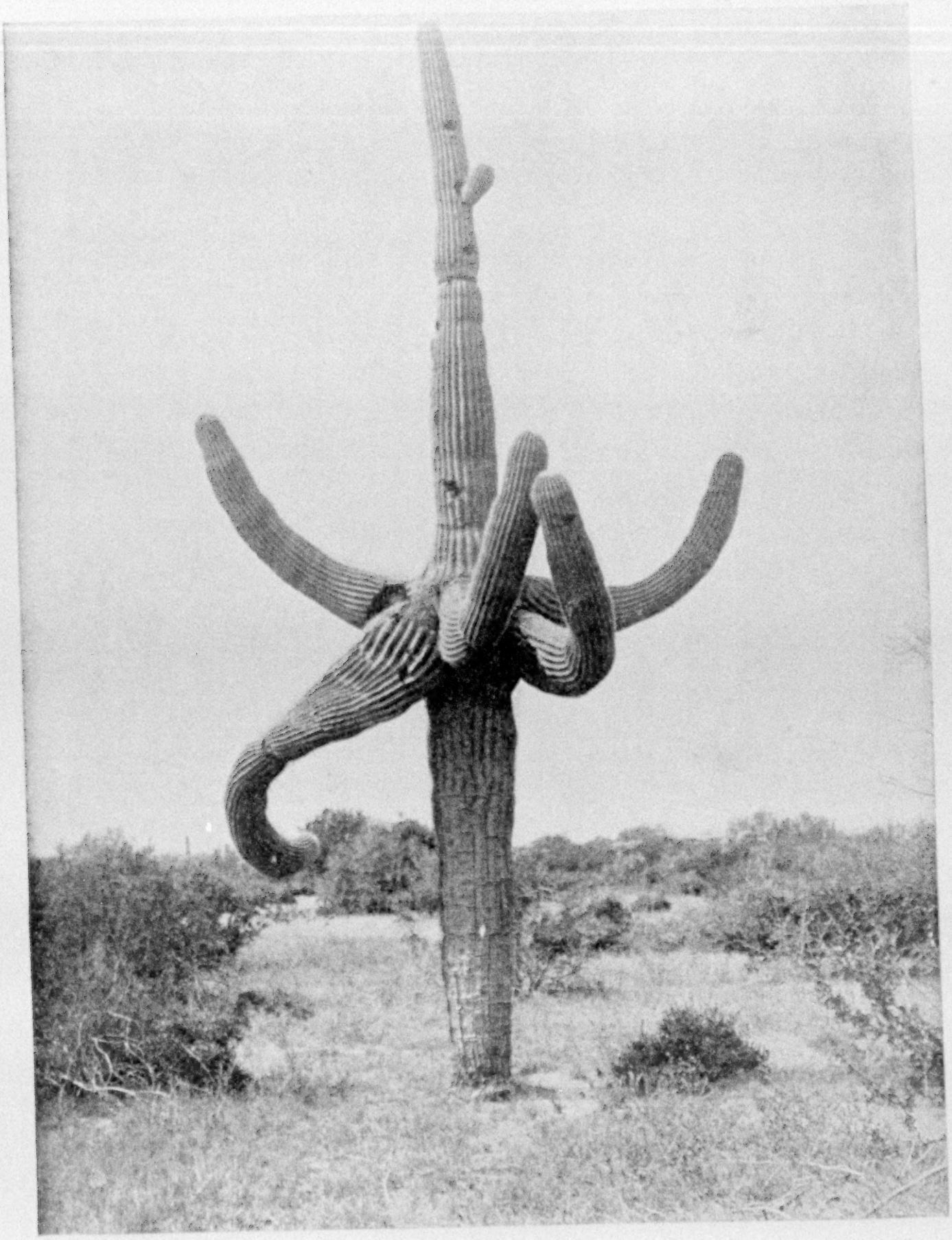
This beneficent climate is responsible for the giant industry of fruit growing which has made California famous over the globe. California furnishes the major part of the very large amount of oranges and other citrus fruits consumed in the United States, and this business has been the potent cause in the development of southern California. Ever since the early days of settlement it was known that climate and soil were favorable, but it was not until about 20 years ago that the great orchards were developed. The splendid success of the business led many to engage in it, until finally most of the available land came under cultivation.

There are two important natural limitations to the extension of orange culture—one is lack of water; the other is frost. Water for irrigation is a necessity, and as the available supply is limited only a certain acreage can be utilized.

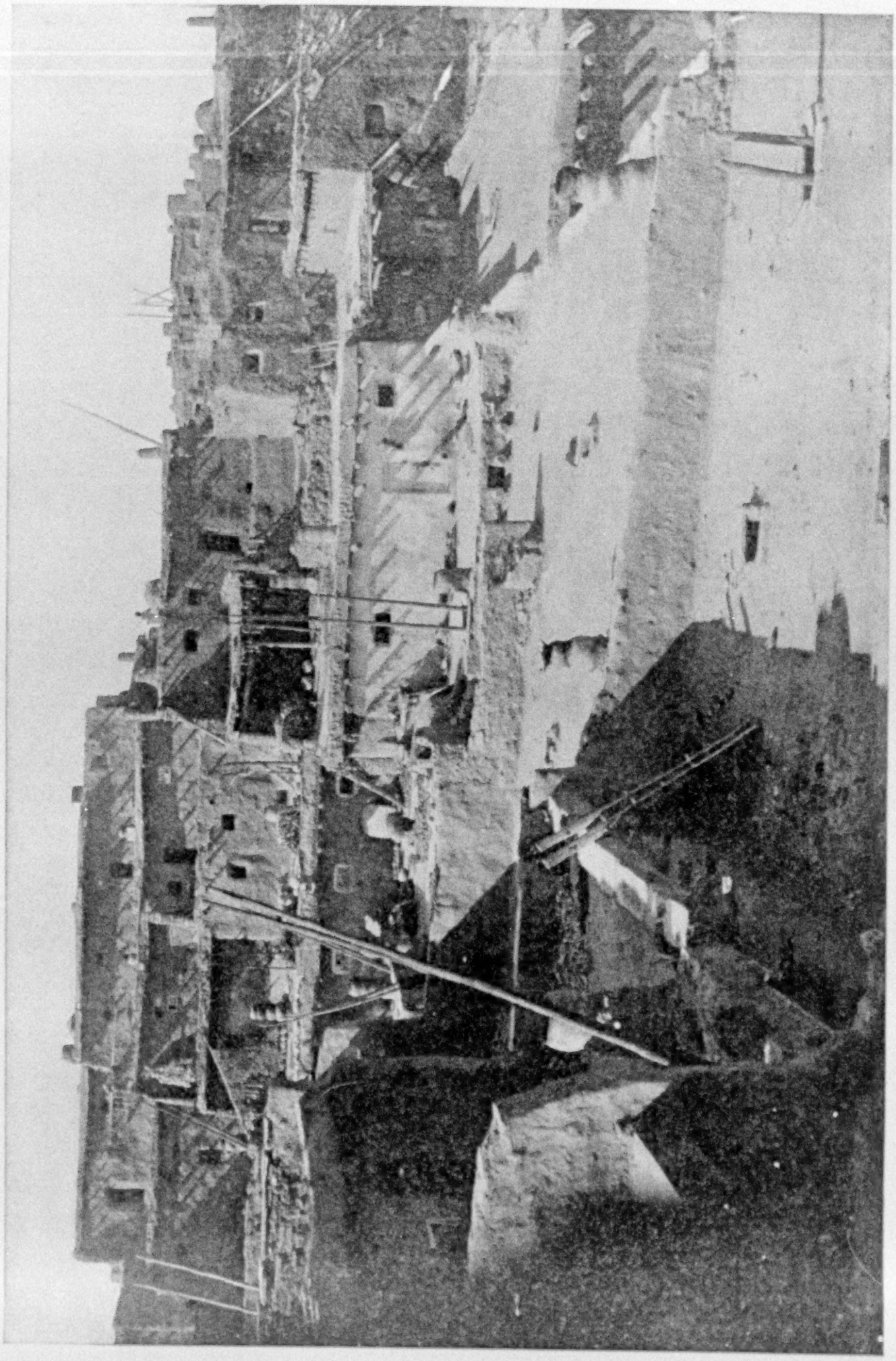
At an early period all the surface waters were taken out in ditches, and then the underground waters were tapped by numerous wells. Storage dams have helped to conserve the surface waters somewhat, but the artesian supplies have been drawn on beyond their capacity for replenishment, and they are steadily diminishing in some districts of large extent.

A few years ago hydrologists of the U. S. Geological Survey made a careful investigation of the amount of underground waters available, and placed the data on maps and diagrams which will afford a definite basis for the water conservation. There are frequent lawsuits concerning underground waters, most of them brought by the man with the little pump when he finds that the company with the large pump is drawing away his water. There are about 3,000 flowing wells and 7,000 pump wells now supplying water for irrigation, with an estimated total volume of about 500 second feet.

The area of agricultural land in the fruit district is about one million acres, of which about one-fourth have water for irrigation and are cultivated. The remaining three-quarters is without water. The new water supply for Los Angeles will be about 260 million gallons



GIANT CACTUS (SAGUARO) OF REMARKABLE FORM ON DESERT SOUTHEAST OF PHŒNIX, ARIZONA



THE PUEBLO OF ZUÑI, IN WESTERN NEW MEXICO

Photo by J. K. Hillers

a day, or ten times as much as is now needed, and the surplus will be used for irrigation until it is required by the city.

The orange and other citrus fruits of southern California have an output of about 30,000 carloads a year, with a net value of more than $15,000,000. Of this, Riverside ships 4,000 to 5,000 cars of oranges, worth $2,000,000 net. Redlands' shipments in 1909 were 4,551 cars of nearly 2,000,000 boxes, valued at $2,764,000. Olives are also a prominent crop, yielding a large aggregate return. Besides her fruits, California raises a great variety of nuts and vegetables. The single item of walnuts sums up $1,500,000 a year. Lima beans, $2,000,000; celery, $600,000; potatoes, $225,000, and hay, $3,600,000, are very profitable crops. Dairy products, including butter, at $1,500,000; cheese, $320,000, and eggs, $750,000, are important sources of revenue to the farmers.

### IMPERIAL VALLEY

East of the mountains in southern California is an extensive desert country, much of it without water, but large areas can be reached by ditches from the Colorado River. The most notable district of the sort is in the Salton Desert, near the Mexican boundary. A few years ago this was a lonely and forbidding region, but now, by aid of irrigation from the Colorado River, it has several thriving settlements, with 100,000 people and 200,000 acres of cultivated land. That portion of it known as Imperial Valley has the greatest development, and with rich soil and semi-tropical climate phenomenal results have been obtained when water was applied. The overflow of the Colorado River in 1906 delayed progress somewhat, but there is no prospect of a recurrence of a disaster of this sort.

One of the best known products of this region is the canteloupe, of which the annual shipments are over 1,800 cars, bringing nearly a million dollars. This valley contains over 400,000 acres of land, and just across the Mexican line are 200,000 more.

### SALT RIVER VALLEY

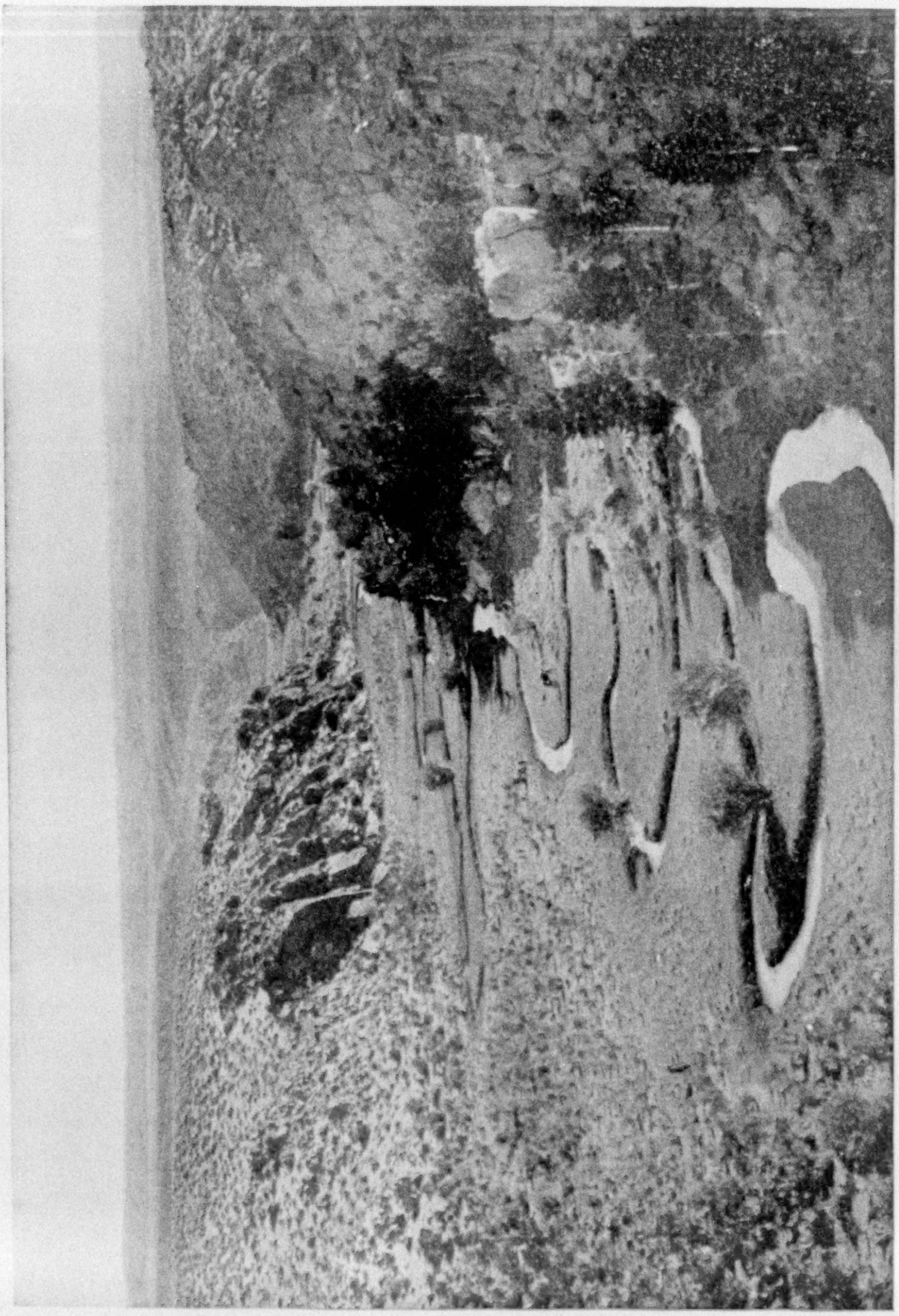
Salt River Valley is the "promised land" of Arizona. It is a very broad, level valley, extending east and west near Phœnix, and lying along both sides of Salt River, a stream which has a large watershed in the mountains of eastern Arizona. The valley is 50 miles long by 15 miles wide, and contains about one-half million acres of very fertile land, of which some 50,000 acres are now under cultivation by canals and pumping.

Normally the valley is a desert, for the rainfall is only from 6 to 7 inches a year, but the river water has been used for irrigation to some extent, and many wells afford supplies for irrigation of small areas. When the great Tonto reservoir is filled there will be sufficient water for 200,000 acres, and cheap power to run pumps to utilize the underground waters more fully for irrigation of an additional area of about 50,000 acres.

The dam across Salt River, erected by the Reclamation Service at Roosevelt for the Tonto reservoir, is 280 feet high, 1,080 feet long on top, with a total contents of 300,000 square yards. It required over 240,000 barrels of Portland cement, which was manufactured by the Government on the dam site. The reservoir, with an area of 25 square miles and a capacity of 284,000 acre feet, is the largest artificial lake in the world. Forty miles below is a diversion dam by which the water is taken out into great canals on both sides of the river that convey it to the valley lands, 15 to 30 miles below. These works will afford a large flow at times, when the water is needed for irrigation. The reclaimed land will cost the settler only about $30 an acre.

The principal product of Salt River Valley is alfalfa, but considerable grain, fruits, and vegetables are also raised. Alfalfa is cut from four to five times a year, with yield of four to six tons an acre, and it sells, baled, for from $8 to $12 a ton. Wheat yields 30 to 40 bushels to the acre.

Sugar beets have been tried in recent years with most satisfactory results, and



CROOKED CREEK, LONG VALLEY, CALIFORNIA: FLOWS IN A FLAT-BOTTOMED CANYON CUT IN THE WIDE DESERT PLAIN

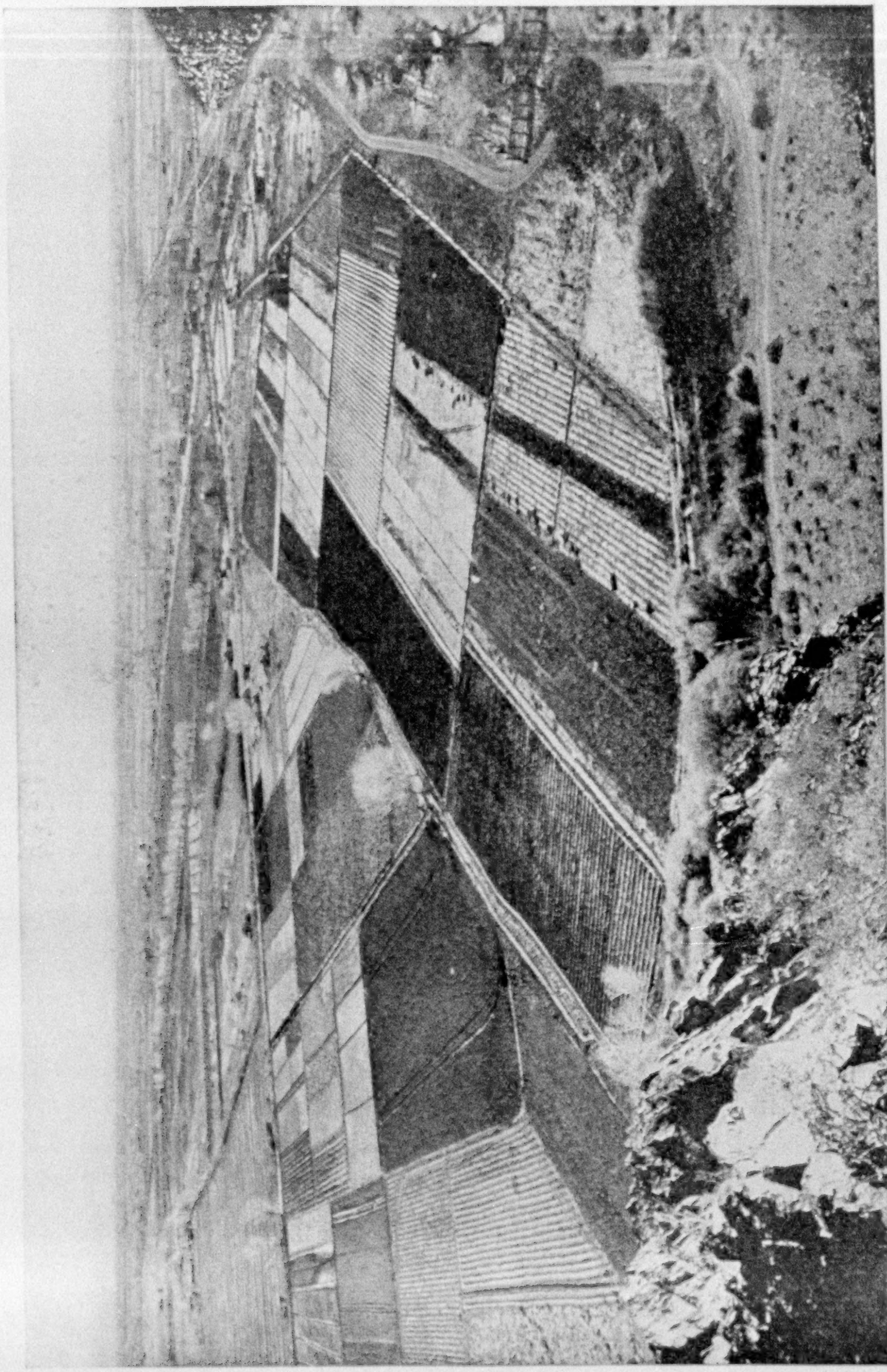
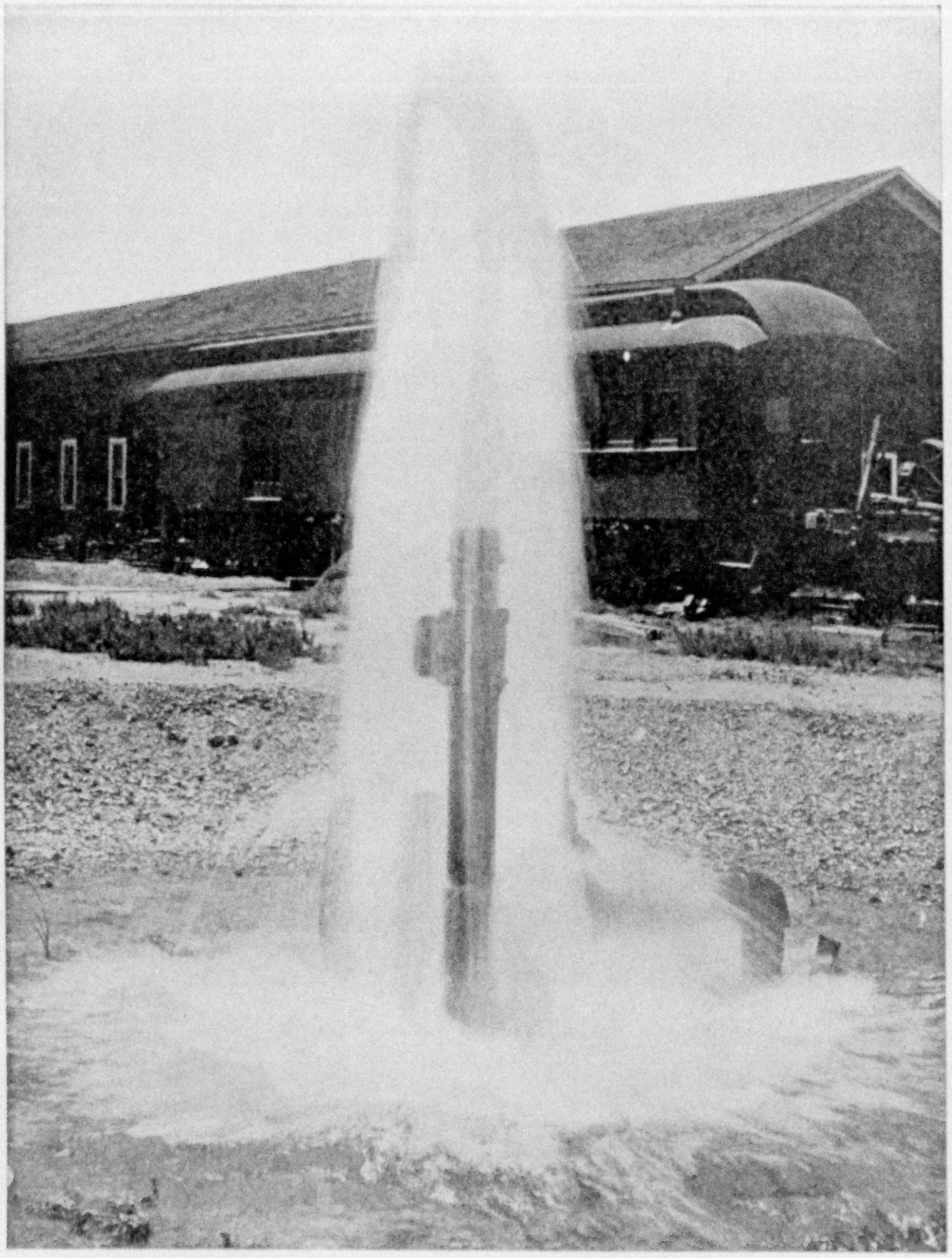


Photo by W. T. Lee

SALT RIVER VALLEY, SOUTH OF PHŒNIX, ARIZONA, SHOWING INTENSIFIED FARMING BY IRRIGATION



TYPICAL ARTESIAN WELL AT ROSWELL, NEW MEXICO

There are hundreds of these wells supplying water for irrigation (see page 657)

40,000 acres of them were planted in 1908, with yield of over 20 tons to the acre. A factory has been erected at Glendale by a Colorado firm, which has a million dollars invested in the industry. The sugar averaged 16 per cent, and a two-months' run of the factory yielded 6,000,000 pounds of sugar.

Choice canteloupes are being raised in increasing number, and in 1908 125 cars were shipped East and West to a ready market. Olives and dates are being produced, and of late the orange business has begun to thrive rapidly, because the fruit can be raised to reach the markets in November and early in December, so that it commands extra high prices. One hundred carloads went East in 1907 at $5 to $8.50 a box, which yielded a profit of $500 to $800 an acre. All the garden products are raised profitably.

I know of one patch of strawberries near Tucson which returned $1,000 an acre net, and many yield $500 to the acre. Sweet potatoes are raised with returns of $300 per acre. Cotton has proven a success in southern Arizona, and it is remarkable in having fiber so long that special gins have to be made for it.

### YUMA REGION

Yuma, in southwestern Arizona, is situated in the low-lying delta region of the lower course of the Colorado River, with its wide stretches of fertile soil and warm climate. The yearly rainfall averages less than 3 inches, but the waters of the great river are available for irrigation, and the operations of the Reclamation Service will furnish a water supply for 79,000 acres. The principal work has been the great Laguna dam built across the river, 4,780 feet long and 19 feet high, to create a reservoir of 10 square miles, with a capacity of 26,650 acre feet and an annual discharge of 11,000,000 acre feet.

The agricultural capabilities of this region are wonderful, for the soil is rich and the climate warm. A great variety of crops has been introduced, from dates to cabbage, and the returns have been phenomenal.

There are many private irrigation projects in various valleys of Arizona, and the next few years will witness the reclamation of a large acreage of land ready for the settler. It is probable that in time all this land will be under cultivation, and central and southern Arizona will be a great producer of useful crops.

### NEW MEXICO AGRICULTURE

Irrigation has been practised for many years in New Mexico, but until lately the product was not large and it was consumed at home. In the past few years operations have been extended greatly in all parts of the country, and now the value of the crops exceeds $25,000,000 a year. Alfalfa for feed is the largest product, but there is a variety of other crops from apples to cotton (see page 655), and in Messilla Valley 4,000 acres of rich bottom lands are affording a highly profitable yield of canteloupes.

The principal water supply is in the Rio Grande, the great floods in which go to waste, but recently work has been begun by the U. S. Reclamation Service on a dam near Engle, to be 265 feet high, to hold the river and create a reservoir 45 miles long to store over 2,000,000 acre feet of water. This water will be largely used in the southern part of the territory, besides furnishing 60,000 acre feet in Mexico. Two other smaller projects in the Pecos Valley will supply water to irrigate rich bottom lands. In 1908 permits were issued for irrigation of 654,500 acres in New Mexico.

In Chaves and Eddy Counties, in the famous Pecos Valley, there is an artesian area with about 700 vigorous wells, some of which yield 200 gallons a minute. The water is nearly all used for irrigation, and some wells irrigate 200 acres or more. The celery at Roswell, which has become celebrated all over the Southwest, is raised in this way.

Dry farming has also been practised to some extent in New Mexico with very satisfactory results when the soil was kept in proper condition, but unfortunately most dry farming is simply taking chances of having sufficient rain to raise a poorly tilled crop.

STOCK

Stock raising has always been a most important source of income in the Southwest, especially sheep, which range in vast flocks through many portions of southern California, Arizona, and New Mexico. In 1908-1909 New Mexico, with about 4,200,000 head of sheep, exported 700,800 head and had a wool clip of 18,000,000 pounds at 16 to 22 cents a pound.

Arizona estimates her sheep at 1,250,000 head. The first sheep, except those in the Navajo herds, were swum across the Colorado River at Needles, in 1876, at the time of the great drought in southern California. It costs about $1 a head a year to keep and feed them, and they pay 100 per cent profit under favorable conditions. The estimate of cattle in Arizona in 1907 was 342,837 head, valued at $3,753,406.

OSTRICH

The production of ostrich feathers has long been an important industry in southern California, and of late Arizona has gone into the business with most gratifying success. The beginning was made in 1885, with an importation of a few birds from California, and the increase has been such that in 1908 nearly 2,000 chicks were hatched. The birds, which now number 2,000, are in Salt River Valley, near Phœnix, where they appear to thrive as well as in their native country.

The birds are plucked every eight months, and the full-grown birds yield a pound of feathers to the plucking, worth about $25. The annual cost of keeping is about $10 a bird. Alfalfa is the principal food. One acre of good stand will support about five full-grown birds. The ostrich needs care when first hatched, but soon becomes very hardy. He matures in four years and is very long-lived. The plucking of the ostrich is done after placing the bird in a small enclosure and covering his head with a hood like a stocking. The picker then raises the wings and carefully clips off the mature feathers. The operation is entirely painless, but care must be taken to remove the dead stumps a couple of months later.

MINERAL RESOURCES

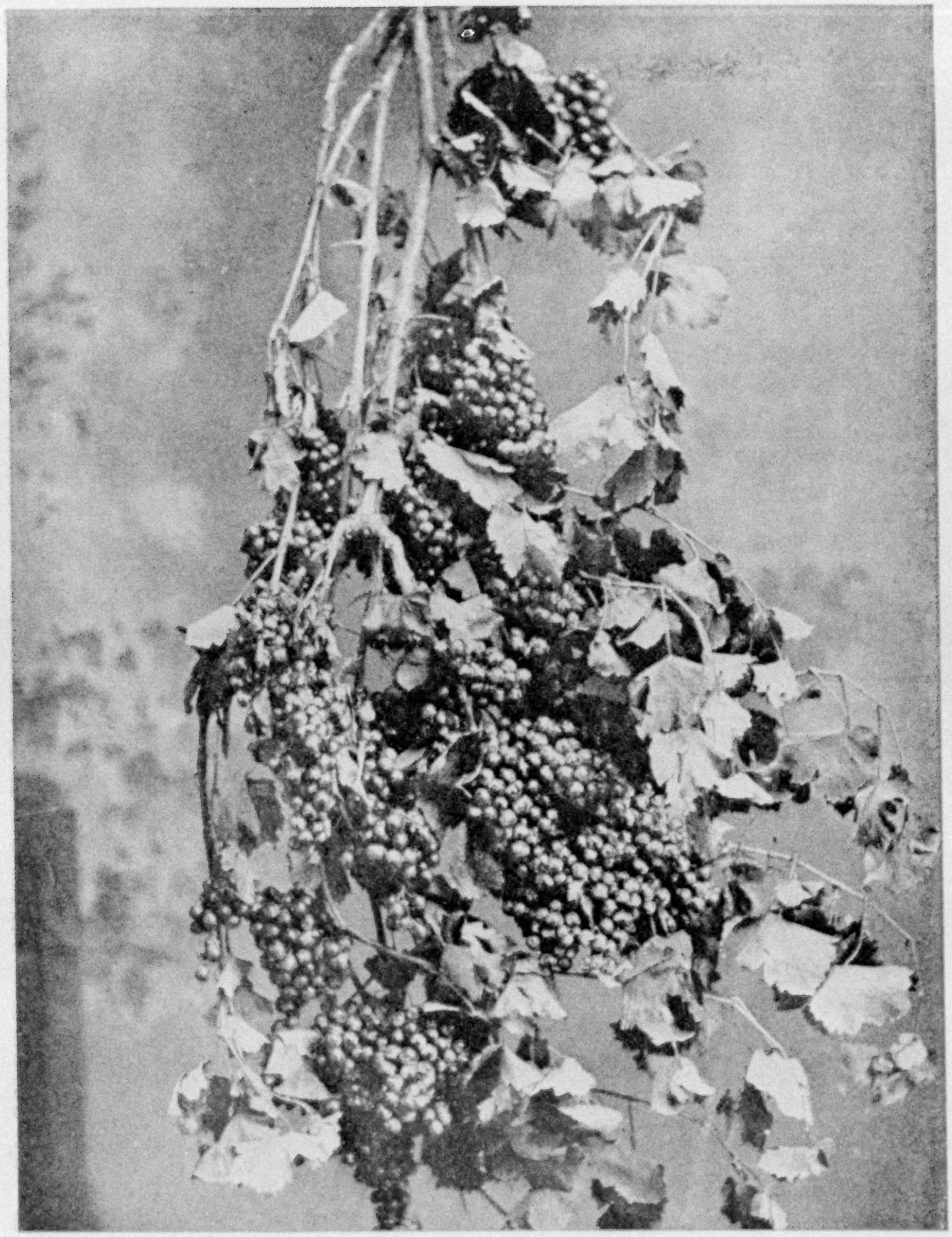
The principal ores of the Southwest are copper, and in the production of this metal Arizona leads the world.

The copper mines of Arizona have had marvelously large production, and while much very rich ore has been mined the deeper workings reveal an almost inexhaustible supply of ore, which will yield good profit unless the price of copper tumbles much below its present low stage. Copper constitutes about 90 per cent of the $42,249,281 aggregate value of mineral products from the territory in 1908.

The largest mines are at Bisbee, Globe, and Morenci, in the eastern part of the territory, and at Jerome, in the central part. There are numerous small mines and new deposits are reported occasionally. The total production for 1908 was 291,584,080 pounds, valued at over $35,000,000. Of this the Bisbee district produced about 40 per cent, the Clifton-Morenci district 27 per cent, Globe 12½ per cent, and Jerome 12½ per cent, approximately. The United Verde mine at Jerome is reported to have paid dividends of $22,270,322 up to 1907. The extent of some of the copper mines is indicated by the fact that in the Copper Queen mine at Bisbee there are 150 miles of rails. Considerable gold is produced in Arizona, amounting to 136,059 ounces in 1908, valued at nearly $3,000,000; silver, 2,571,698 ounces; lead, 2,995,183 pounds, and zinc 2,457,099 pounds.

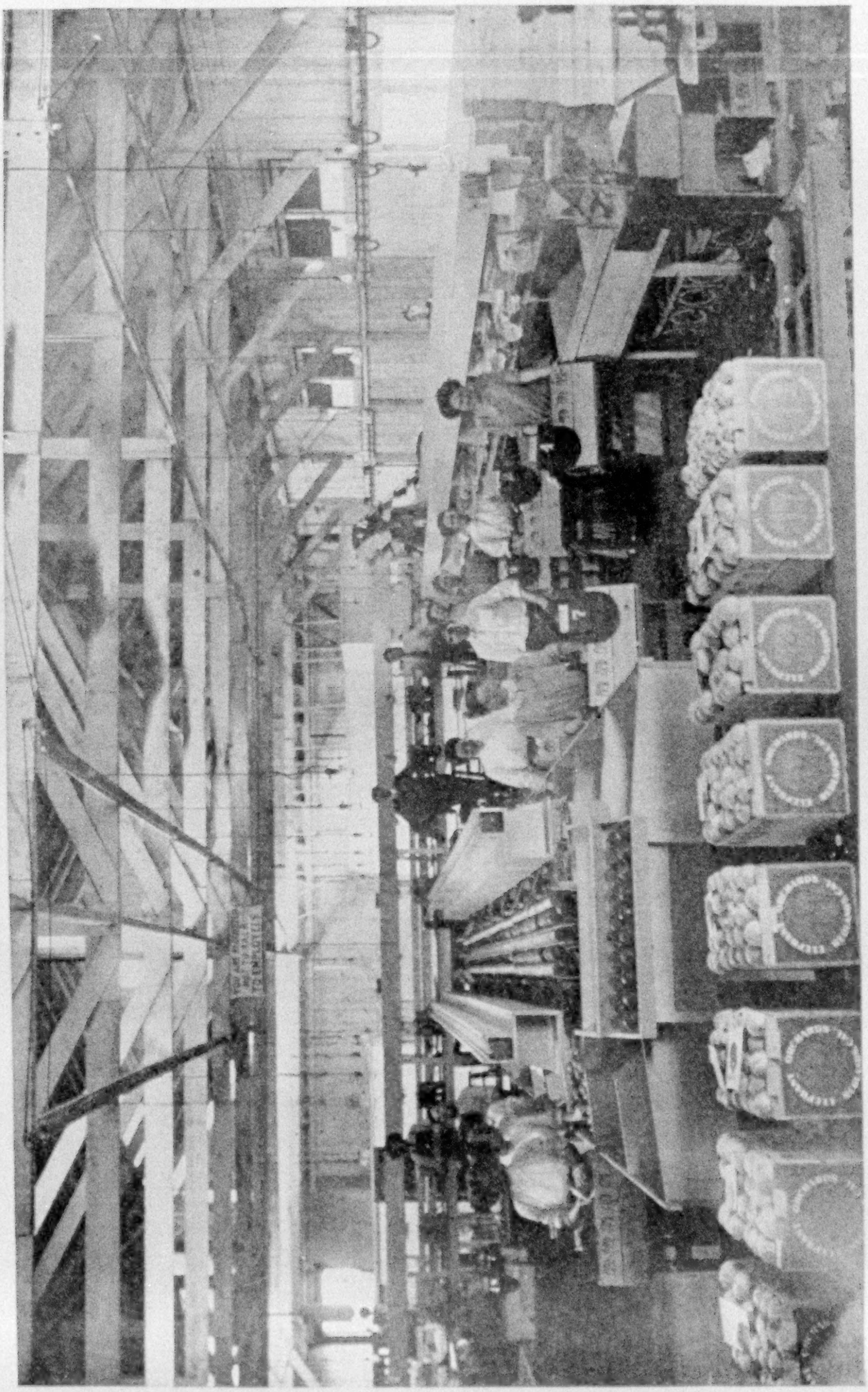
New Mexico has large mining interests in gold, silver, and copper, there being 134 mines working in 1908, with total output of $1,529,091, of which copper was $806,867, silver $214,673, and gold $298,757.

New Mexico has very extensive deposits of coal. In the year 1908-1909 the coal mines yielded over 3,000,000 tons, having a value of $3,881,508, including



A BRANCH OF MALAGA GRAPES RAISED BY IRRIGATION IN PECOS VALLEY, NEW MEXICO

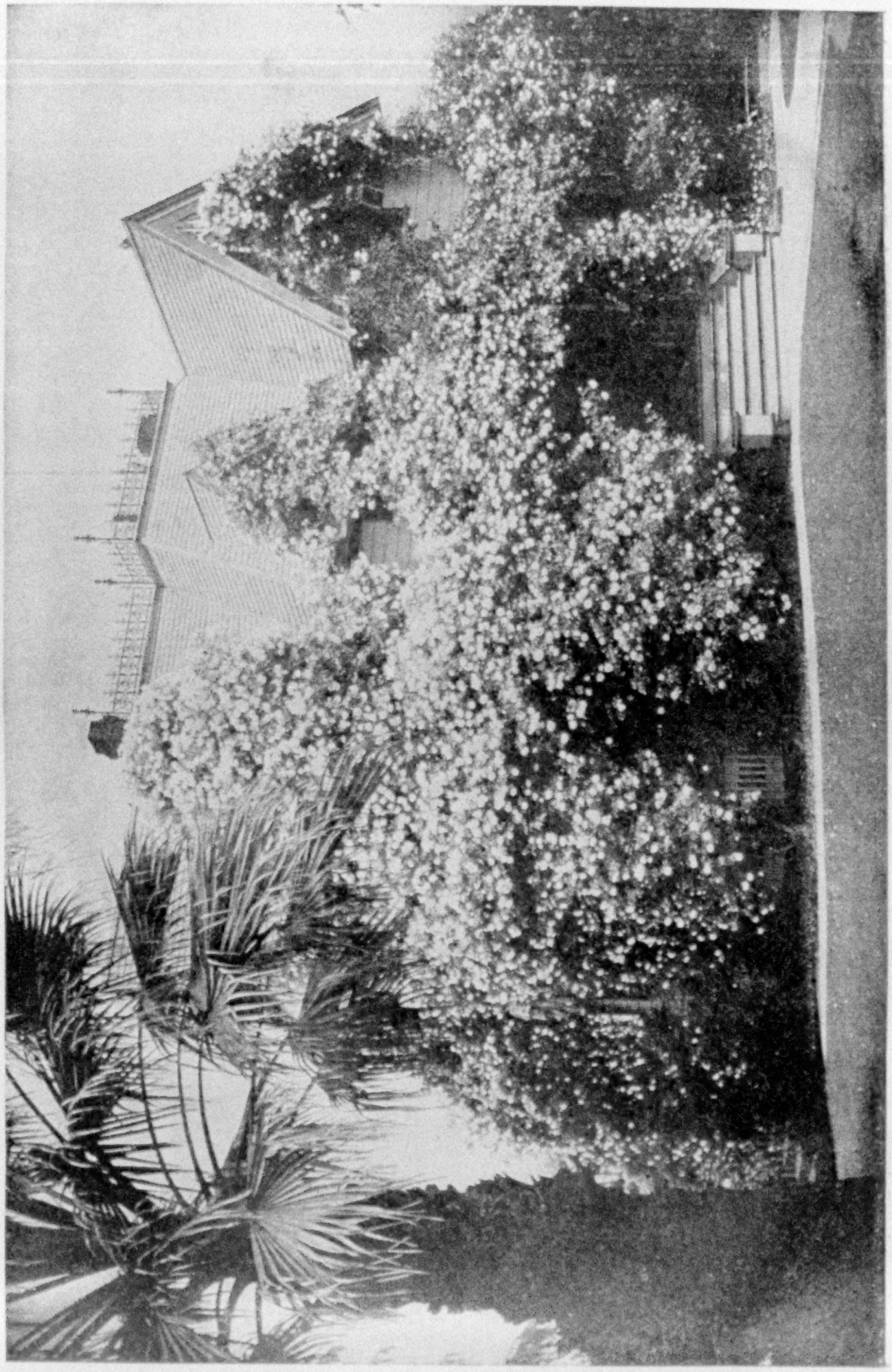
XUM



INTERIOR OF ORANGE PACKING PLANT AT REDLANDS, CALIFORNIA

The oranges are carefully graded and wrapped in tissue paper by machinery

MARENGO AVENUE, PASADENA, ONE OF THE FINEST RESIDENT STREETS, SHADED BY GIANT PEPPER TREES



A ROSE-EMBOWERED HOUSE AT REDLANDS, CALIFORNIA

Photo by W. C. Mendenhall

ORANGE GROVES OF REDLANDS REGION, CALIFORNIA, WITH SAN BERNARDINO MOUNTAINS IN BACKGROUND, ON WHICH SNOW REMAINS UNTIL SUMMER

coke, into which about 12 per cent of the coal is converted.

The U. S. Geological Survey estimates that there are 165,000,000,000 tons of coal available in New Mexico. In the Hopi Indian reservation, in northeastern Arizona, there is an undeveloped coal field of 2,500 square miles containing an enormous tonnage of coal. It is 75 miles from the railroad.

The great oil fields of California are in the southern part of the state, and with rapidly increasing production they promise to be the largest producers in the country. The output in the past year is estimated to have had a value of $43,000,000 or more than the gold production of the state, and nearly 10 per cent of it is produced in Los Angeles.

One well recently sunk near Bakersfield struck oil at about 2,300 feet, and the flow was so powerful that it at once became unmanageable. The oil spouted out at the rate of about 25,000 barrels a day, but fortunately it could be held in a great pool, while powerful pumps have since kept forcing it into a pipe line by which it can be shipped. Up to May 3 it had produced 2,000,000 barrels of oil. The oil sells at 50 to 90 cents a barrel, and is extensively used for fuel, as coal is expensive, and five barrels of oil have approximately the heat value of a ton of coal.

The oil occurs in some unexpected places; one of the extensive fields is at Santa Maria, in the midst of the old mission grounds, while in part of Los Angeles there are hundreds of derricks among the houses, and at Summerville many wells are in the water along the shore.

Excepting its great oil fields, southern California has not been a large producer of minerals. Several gold mines in the desert region have an aggregate output of about $200,000 a year, and this, with various ores, granite, cement plants, and brick yards yield a total of about two million dollars. This is not including the borax, which comes mainly from southern California, with a production of 50,000 tons, valued at about $1,000,000. Formerly, much of this material was transported many miles over the desert by the much-advertised 20-mule team, but now the railroads cross the country, and the energy of the mules is directed into other channels.

### POPULATION

The rapid development of southern California in the last twenty years has been phenomenal. It has resulted largely from the disposition of Eastern people to migrate to a region which afforded the climatic advantages favorable to health and agricultural opportunities, especially in the very lucrative business of raising oranges and other fruits.

Los Angeles, the metropolis of the region, has grown rapidly and taken a prominent rank among the cities of this country, with a rate of growth second only to that of Seattle. It is a city of large business interests, and has many thousand comfortable homes, some of them palatial. In 1846 it had a population of only 1,200, in 1880 of 11,183, in 1893 of 75,000, while in 1908 it had increased to 300,000, and this high rate of increase continues. That the city has the characteristic optimism of the West is shown by a recent bond issue of $23,000,000 for a water supply to be brought from Owens River, over 200 miles, with volume enough for a population of 5,000,000.

The population of southern California is mostly American, as is well illustrated in the registry of the last election in Los Angeles, when it was found that out of 33,000 voters 5,000 were born in New York, 4,500 in Ohio, 4,000 in Illinois, 3,000 in Pennsylvania, 2,000 in Iowa, 2,000 in Missouri, and only 5,000 in California. Of the foreigners, who are only in small proportion, Germany furnished 2,000.

The assessed valuation of Los Angeles County is $585,000,000. The city is 22 miles from the nearest harbor of San Pedro, but it transacts a large and rapidly growing foreign and coast trade. More than $1,000,000 has been spent on this harbor, in addition to a $3,000,000 sea wall.

The population of the inland portion of the Southwest is very small, and there are many districts in which there is not one white man to 500 square miles. According to estimates by the governor, Arizona had a population of about 200,000 in 1908, and New Mexico was estimated at 450,000 for the same year. The area of these two territories is about 235,600 square miles. A very large proportion of the population is American born, but many immigrants are now coming in.

Considerably less than half of the New Mexico population is classed as Mexican, and there is a small proportion of persons of Mexican origin in Arizona and California. The principal cities are Phœnix, the capital of Arizona, with a population of about 15,000, and Tucson, Arizona, and Albuquerque and Santa Fé, New Mexico, which are approaching the 10,000 mark.

Pasadena, Riverside, and Redlands are thriving cities, with rapidly increasing population, largely of persons from the East who prefer California, especially in winter. Pasadena is well named "the city of flowers," for it is filled with them. Riverside and Redlands, and a host of smaller places in the orange country, have hundreds of handsome homes, miles of fine avenues lined with splendid trees, and many beautiful environments. All the cities of southern California are growing rapidly, and San Diego, with her excellent natural harbor, has attained a population of 40,000.

### PUBLIC LAND

The amount of public land available in the Southwest is greater than in any other portion of equal size in the West. Owing to widespread desert conditions, limited water supply, and rough surface, however, only a moderate proportion is suitable for immediate use.

Nearly all of southern California east of the mountains is open for settlement, but in the fruit region on the coast side all the valley lands have been taken.

Arizona has about 40 million acres of public lands, and New Mexico about the same amount. In the latter territory, in 1906 to 1909, nearly 4 million acres were homesteaded and over one million taken under the desert-land act. Four-fifths of the homesteaders were from other parts of the United States. It is claimed that in New Mexico there are 13 million acres left which are suitable for dry farming and 2 millions capable of irrigation. In Arizona only about 7 per cent of the land has been taken up, and only about 20 per cent of this is under cultivation.

# A LAND OF ETERNAL WARRING

By Sir Wilfrid T. Grenfell

Author of "Labrador: The Country and the People," "Vikings of Today," etc.

EARLY descriptions of Labrador are not encouraging, even though its discoverer, the Viking Biarni, son of Heijalf, came from Iceland, and was naturally prejudiced in favor of a country at least more favored than his own. He did the best he could for it, calling it "Wineland," on the principle that Erik had christened Greenland, visibly that "it might draw men thither if the land had a good name."

But Thorwall, the poet of the expedition, has left on record his most unfavorable impressions, which it may be as well to quote:

> People told me when I came
> Hither all would be so fine;
> This good wineland known to fame,
> Rich in fruits and choicest wine,

Now the water pail they send;
To the fountain I must bend,
Nor from out this land divine
Have I quaffed one drop of wine.

and later,

Let our trusty band
Haste to Fatherland,
Let our vessel brave
Plough the angry wave,
While those few who love
Wineland here may rove
Or, with idle toil
Fetid whales may boil.

Many years of Labrador life have left in my mind at least one indelible impression. It was created the first day I set eyes on its rocky coast. It was under a cold, sullen sky, from the icy bosom of the polar current that swathes it, as we caught a glimpse of a low, naked line of headlands and small, barren islands, over some of which the heavy Atlantic swell was making every now and again a clean breach, while here and there great ominous "sea horses" raised their gigantic heads, as they charged furiously over uncharted reefs, which themselves neither gave quarter to nor expected it from anything.

Truly, it is a land of eternal warring. Everywhere along its coast-line great seas ceaselessly pound as with the hammer of Thor into its adamantine sides. The almost resistless arctic ice-flow growls and groans as it crushes, cleaves, and smashes the very face of nature, while the monster bergs outside, like ominous ice giants, roar and crash as they vainly battle with their still more resistless enemy, the summer sun.

Where in the more sheltered spots gentler nature strives to spread a covering over the nakedness of the land, abysmal cold wages battles with the tenacious plants and scrubs, which grow gnarled and knotty in the conflict. The few animals that in any number can survive in its wilds, are especially endowed to resist its apparently never discouraged efforts to destroy the very source of life.

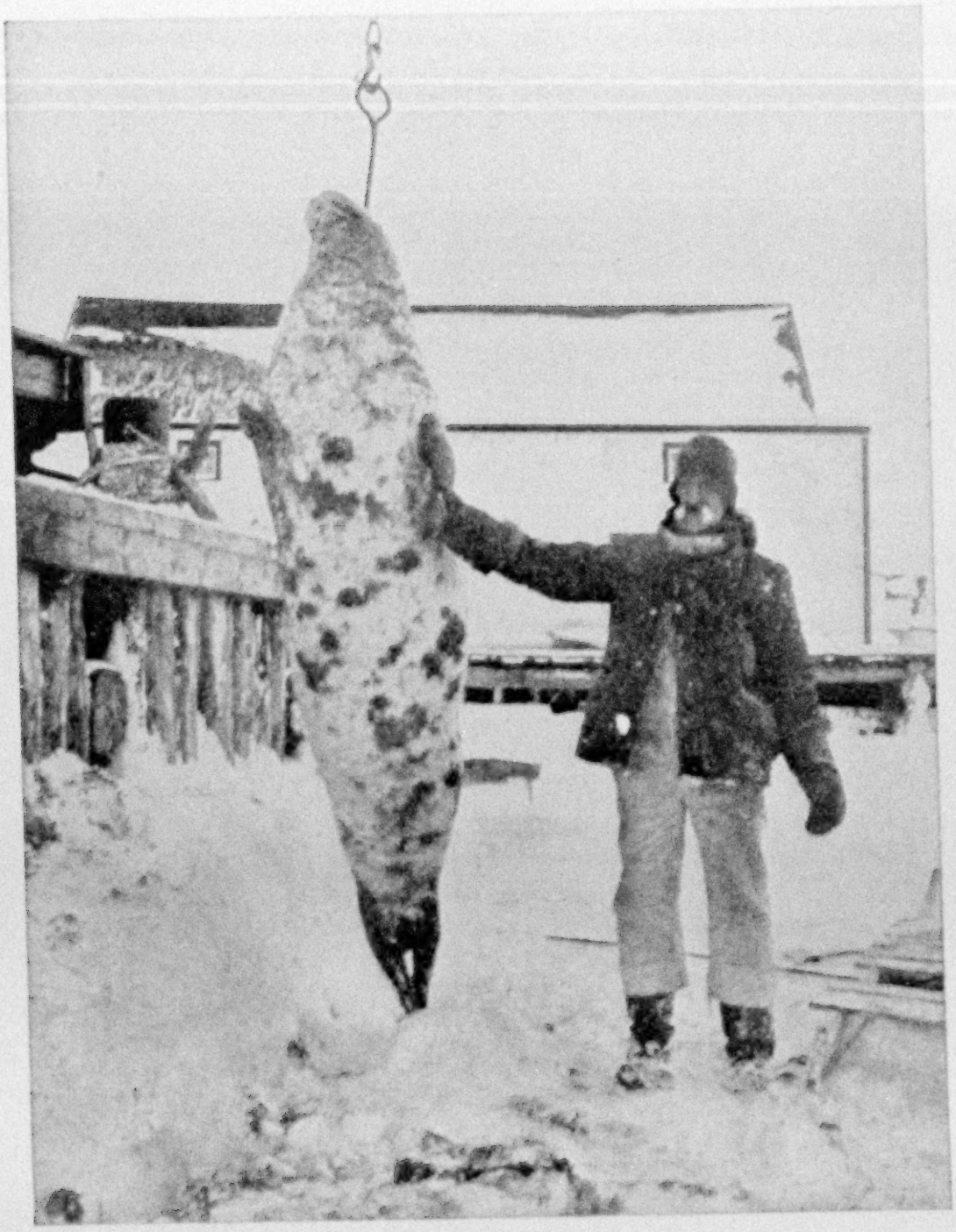
Cradled in its rocky fastnesses, resistless storms sweep madly its already almost denuded bed rocks with a generous abandonment, as if the chance of effecting destruction justified any outlay of energy imaginable. It is a land well suited for the location of the traditional wicked man, as little likely to afford him any dangerous liability to peace.

As one approaches it from the Atlantic and passes its high portals, the cliffs of Belle Isle, the traveler spies a stout log house perched high up on a barren ledge clinging to the very face of the cliff. Suggestive sight: it contains cached the necessities of life against the inevitable day when some poor voyagers shall find themselves suddenly dependent on its savage clemency. Meanwhile, the thoughts of those who know fly to the poor creatures from the "Dainty Lady," the liner *Scotsman*, which, laden with Christmas cheer, late one fall received the hospitality of its eastern ledges, and now lies a scrap heap in her deep-water graves close by. One sees, meanwhile, visions of women dying in their tracks as they painfully struggle toward the western end for shelter. Sometimes one seems in its storms almost to hear their screams of joy over just such victories.

Viewed, as those who frequent it mostly view it, from the sea, one would think its sole harvest was the countless ice-borne erratics that crowd every hillside and crown every sky-line, just where other countries would be flaunting flowers, fruits, and trees.

Still there remains in my memory, after all this lapse of years, the intense curiosity I then felt to learn what kind of human beings such an environment had evolved. Since then I have learned that in the realms of human life also the same stern conditions maintain. Life is truly a battle in Labrador, and its conditions are responsible for a white race as remarkable for their adaptability to live under the very hardest of physical conditions as the native Eskimo they are steadily replacing. These little arctic natives can withstand anything except civilized man.

But Labrador, beyond being a place of war, is a land of contrasts—a land where extremes meet—and where no man dieth

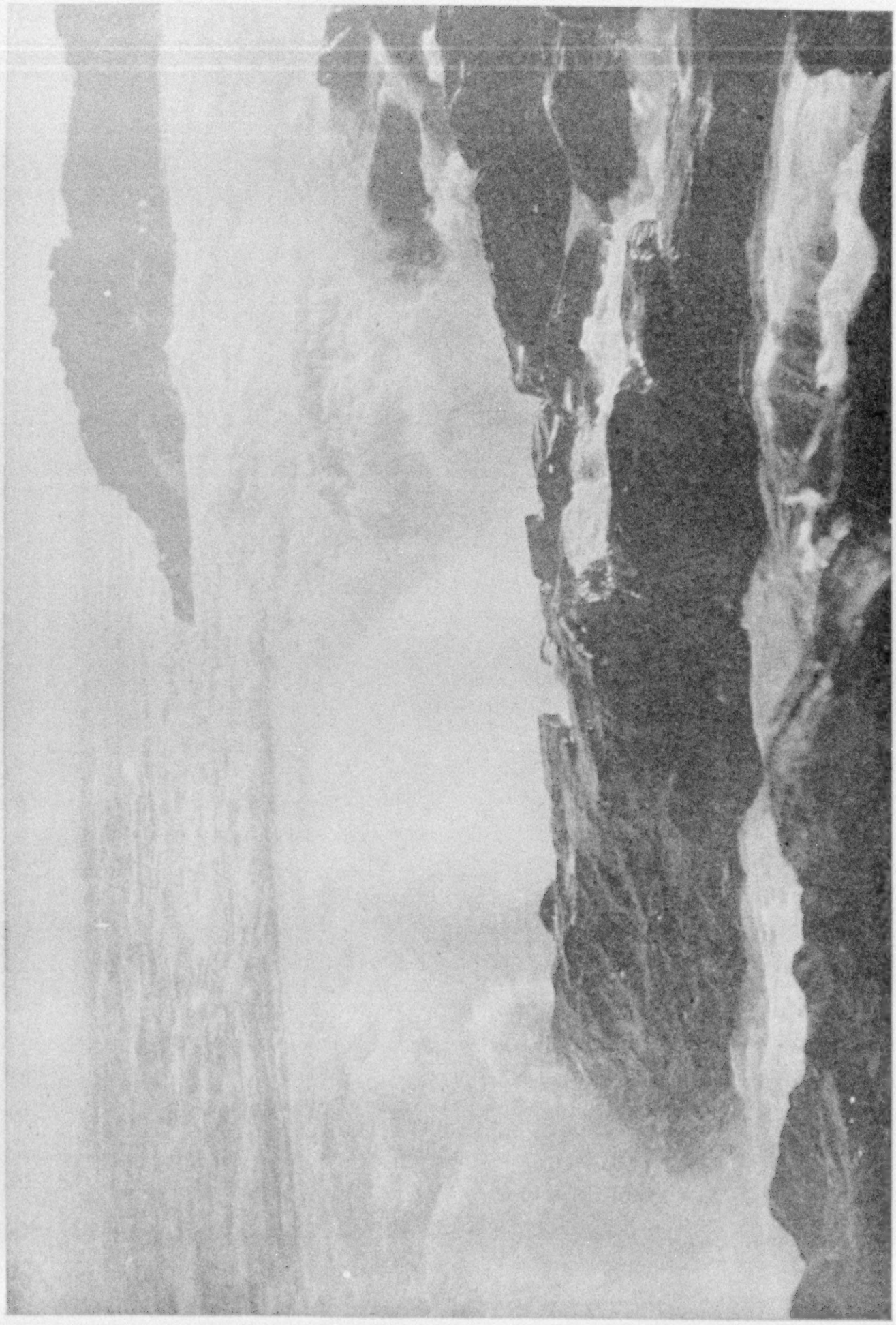


HAULING UP AN OLD HARP SEAL IN WINTER ON THE WHARF

We eat these and feed dogs on them, and sell the skin and fat

from monotony of physical circumstances. Scarcely a stone's throw from this ceaseless strife one finds oneself in a land almost of oppressive silence—a country so utterly devoid of the busy hum of human life that the dominant idea forced upon one is, "Can I be certain I shall ever again get back to the haunts of men?" while visions of the uncertain opportunities for communication with the world outside rise unbidden to the mind.

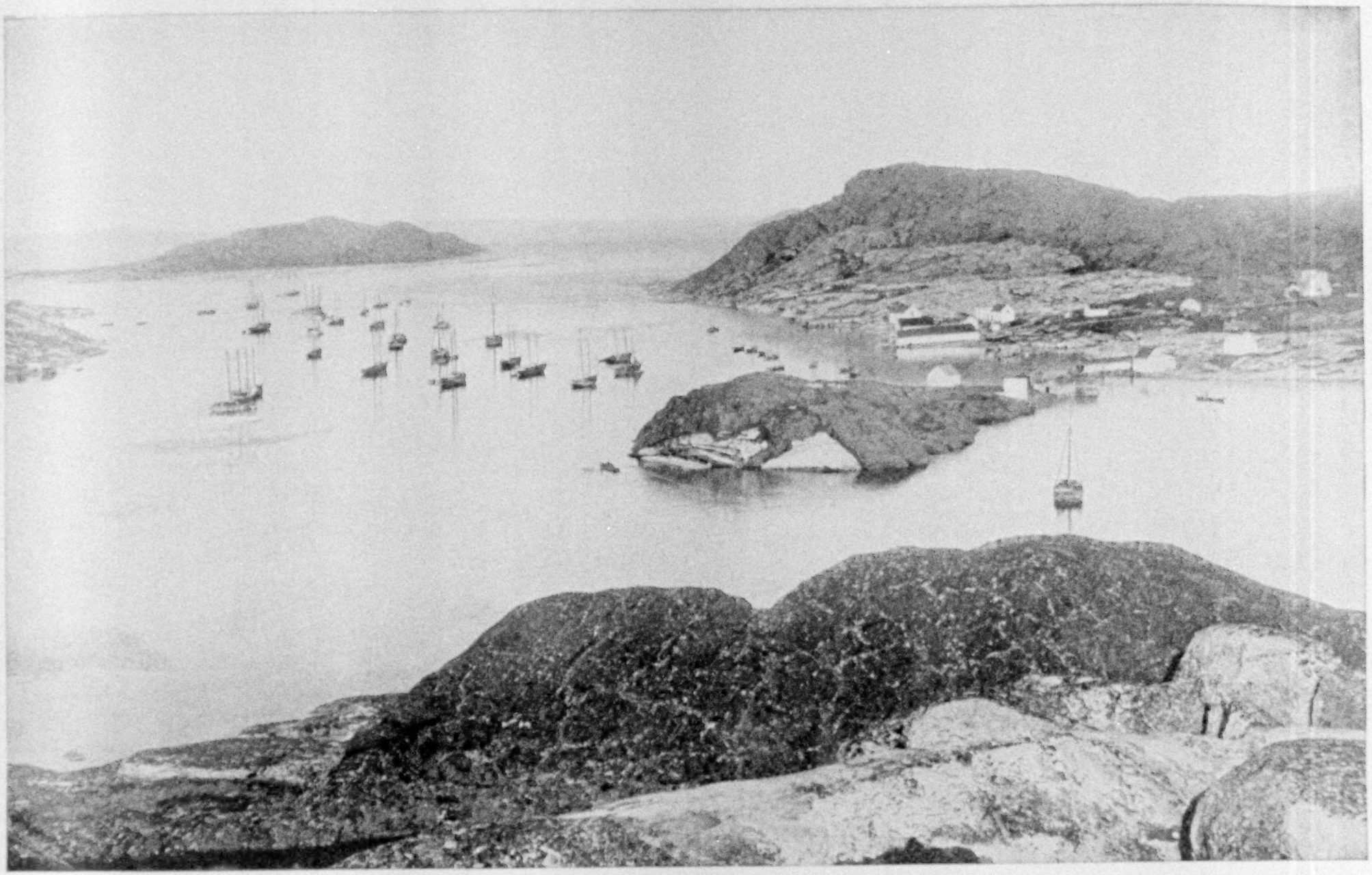
Soon, however, memories of its generous spaces, its glorious fiords, its keen, bracing air, its call for resourcefulness, its rich sea harvest, its noble rivers and plenteous salmon, its wily, silent animals with their priceless skins, its countless deer herds come back to cheer one. Its splendid evergreens, its gorgeous mosses, the carpet bedding of its brilliant lichens all serve to relieve the first chill of its barrenness. Add to these its beauteous nights, its long twilights, the fantastic



A BREAKING SEA ON THE ROCKS

HEBRON, LABRADOR, SHOWING MORAVIAN STATION

This mission from Moravia was founded by Zinzendorf in 1770. It has six stations



INDIAN HARBOR—OUR HOSPITAL—A LABRADOR FLEET HARBORING—MOUTH OF HAMILTON INLET

Peary's first place of call from the north, and the most northern wireless station

colors of the moon shining on its weird ice and deep blue seas, the unearthly loveliness of its auroras, and the magnificent tracery of its northern cliffs. Such a land is it of changes and of contrasts that those who love it at least may be forgiven for thinking it the borders of fairyland.

It is indeed a fine set of people it has produced, for we count as Labradorians the thousands of men and women from Newfoundland who every year come to wrest a living from its reluctant grasp.

I was watching one day from our decks a fleet of what seemed such tiny schooners to be battling with the circumstances of Labrador, as to suggest foolhardiness on the part of those who handled them or indifference, except to gain, on the part of those who owned them. A number of boats had come alongside, bringing patients or visitors from most of them. Some comment made as to their size was half heard by a woman from one of the schooners, and she turned and told me about it.

Apparently it was "her venture." Her husband and three sons had been forced to fish home, "having no boat large enough to carry them to the Larbardore." She had stimulated them to put their all into this small 20-ton vessel. They had been unable to pay a crew, so she not only let all her boys go, but went herself, and to fill up the complement persuaded her eldest boy's young wife to join them also. No wonder the vessel loomed up large in her eyes, for now all the earnings of the "ship" would be kept in the family.

Sea love, self-reliance, and optimism are the three strongest traits of character developed in our people, with rather more than the ordinary amount of fatalism.

There is no doubt the people are tough—tough as their own sharks, they say, which will come to a bait made of their own liver, or continue to eat after being disemboweled. Anyhow, the latter are so unemotional, that I have gaffed three with a boat-hook prodded into their heads as they swam on the surface in the same pool, and then hauled them out to freeze ignominiously on the floating ice.

I have lain shivering in my bag on the floor of a house, when the youngsters have been curled up in a heap with "ne'er a covering," and snoring enough to shake the rafters. (A great many suffer with adenoids.) I have tried to allure them to drink cocoa and milk on a cold morning, and seen them pour it surreptitiously outside the door as being "too full o' sweetness," and heard a man say and mean it, "you give me a lassie duff in the morning and that'll last me all the day."

I have seen our postman start off in winter on his fifty-mile tramp with nothing but a piece of dry, hard bread in his pocket, and this he has been doing these past forty years.

I have known a woman (with now ten children) put off laying up for her confinement till she had to run from the wash-tub, leaving her husband's overalls unwrung, and be up and wring them herself three days later. She was at the time living on dry flour, and not once a week getting enough of that. She had no bed clothes at all, and she told me her leaky house has prevented her turning over in bed because her dress was frozen to the wall. Herself and children are now my flourishing neighbors. She never had a day's real illness till ten days ago, when she came into the hospital and had her appendix removed.

In my mind there is no doubt, however, that Labrador can maintain a good population, but at present no capital has been invested there except in the fishery and furring. Neither of these industries do practically anything to enrich the country, seeing that almost every fish caught and every fur killed leaves the coast as it is, and is turned into money elsewhere.

Cod, salmon, and trout are exploited rather than fished. Rivers have been barred with nets for years. The indiscriminate use of cod traps with small mesh leaders destroy every year thousands of salmon-peal seeking the rivers, and, in the opinion of every one, injure

LABRADOR FISHING SCHOONER, BLOWN UP HIGH AND DRY AFTER A BIG GALE

These storms are rare in Labrador; a really bad gale doing damage of any extent to craft is quite infrequent

very seriously the cod fishery itself by almost entirely preventing the great shoals coming inshore to feed. No means are taken to recuperate this fishery. There exists no fish hatchery, and no scientific use of deep-sea thermometers. Only a very few use preserved bait, and there is no bait-freezer on the coast, and no cold storage to carry away fish fresh to market.

As yet the putting up of fresh codfish in tins has not been successful in the markets because not backed by capital and advertisement. We used the past winter side by side the fresh fish frozen and some excellent tinned cod put up by an enterprising firm from Fogo, Newfoundland, and as yet at least no one has been able to tell which fish they were eating. What has happened to our mackerel and our marvelous herring I do not know; all I am able to state, no scientific efforts have been made to find out.

The survey of the coast is so ancient and so unreliable that we have devoted considerable time to making charts of our own, in which efforts I have during two summers been helped by his excellency Sir William MacGregor, the former Governor of Newfoundland.

Till quite recently not a single lighthouse served to help the numberless craft plying their calling on the coast, and still today not a single harbor has a light or has in any way been artificially improved.

I remember well when the only light

MY LEADING ESKIMO DOG, "CÆSAR": BATTLE HARBOR, LABRADOR

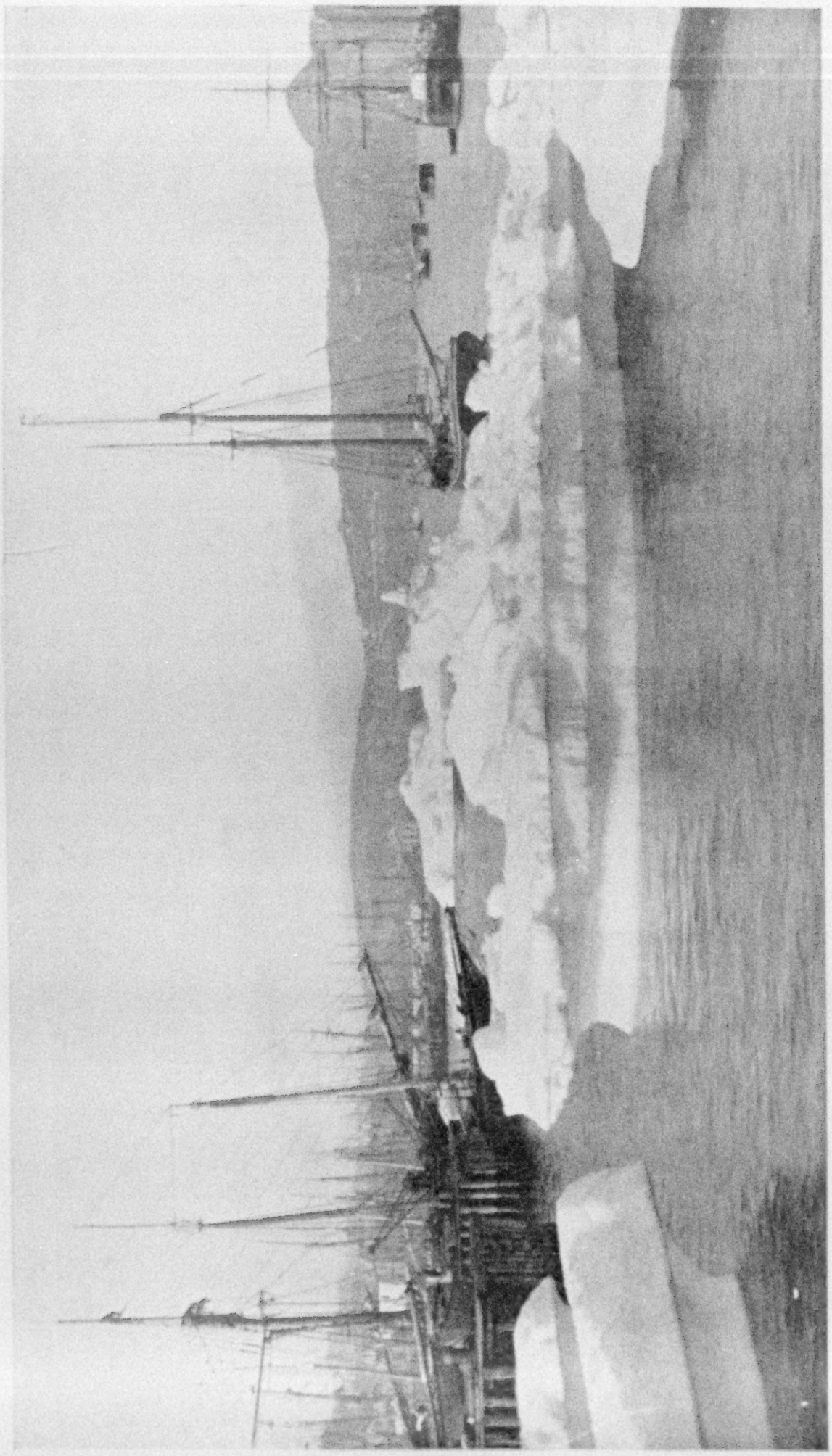
on the coast was from the north window of a tiny building put up by pious hands for religious services in summer. In this two large kerosene lamps used to be swung round to face the north windows every dark night in the fall of the year, to be a literal guide to the poor schooners trying to make a safe anchorage on a very dangerous part of the coast. Once because this light was out I had to steam to my anchors for 24 hours to save the ship, while all of seven schooners anchored near were driven on the rocks.

For our own consumption we still get plenty of herring, and they are the largest, fattest, and sweetest in the world. As an old resident of Yarmouth, England, one should know something about herring as an article of diet.

Practically no use is made of the billions of capelin that can be bailed out of the sea with a dip net. That they could be preserved profitably there is no question.

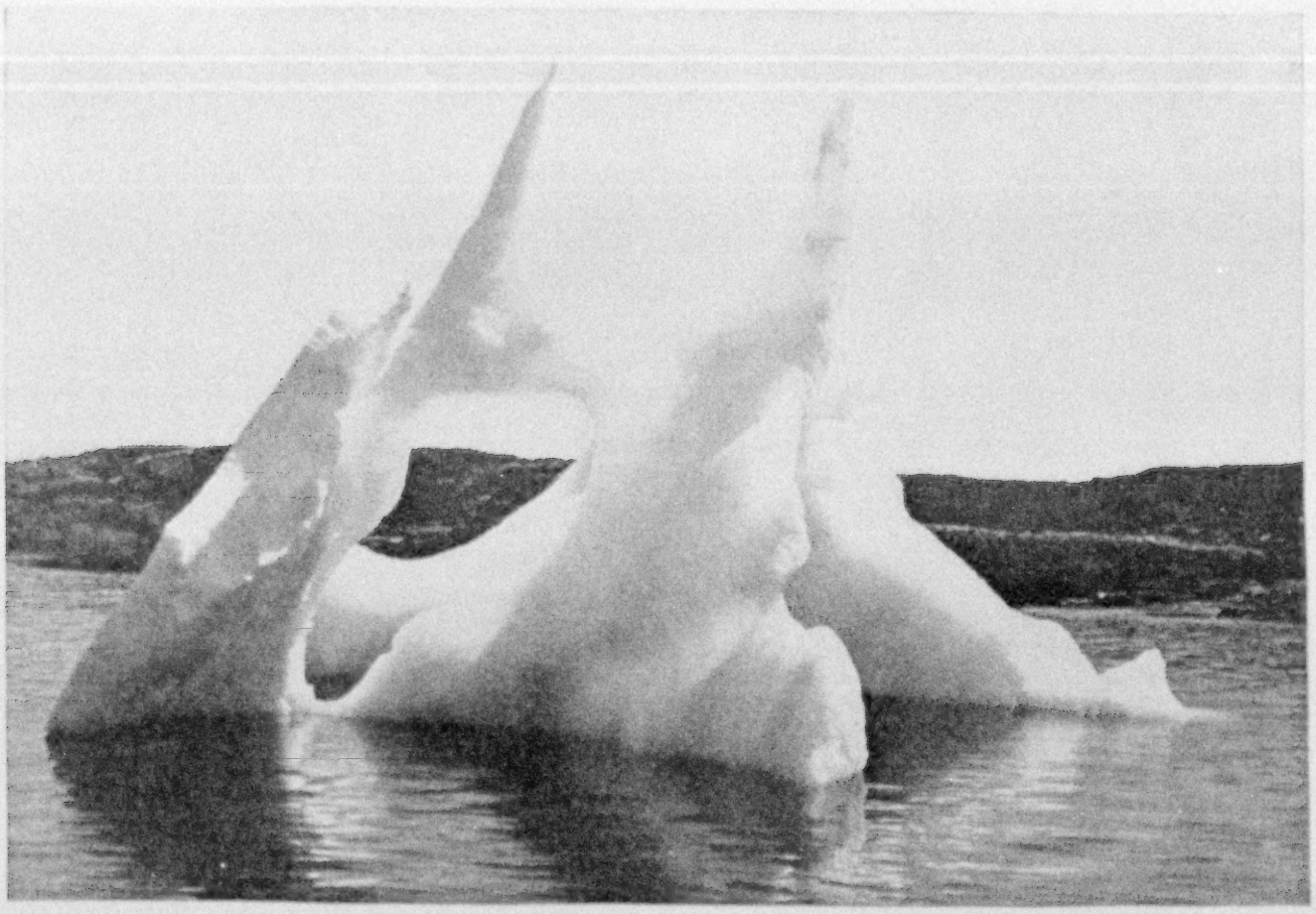
The other sea denizens of value that are exploited at present are whales and seals. The former are not in any great abundance, and the factories do not return more than the outlay that such a speculative business calls for. The hump is the commonest of our whales, a smaller animal than the rest, and not nearly so valuable as the larger sulphur-bottom, or the occasional sperm that strays into our waters.

From 50 to 100 whales is a paying season, and as with the hogs at Chicago there is very little wasted, even the



LABRADOR SCHOONERS IN MAY IN SAINT JOHN'S HARBOR

They come there to get their outfit of flour, molasses, pork, tea, and salt for curing fish. These "pans" of ice are called "Growlers," and are the remnants of the Arctic floe



A WEIRD PIECE OF ICE IN BATTLE HARBOR

blood being collected and turned into fertilizer with the bones. The products of the ductless glands, which as the creature is a mammal should be really valuable, have never yet been extracted. The University of Kansas, through its enterprising industrial chemistry department, is anticipating work on these from the pineal gland to the suprarenal capsule next year.

Whales seem to depend for safety more on their ears than anything, their eyes being of little value. Indeed the eye with all our animals except birds is least relied on. A fox will jump into the arms of a man on an open marsh if he keep still and is down wind. A stag will run right up to a man, who stands without moving in the lead it is traveling. I have seen a stag charge down on a man with a head and horns of a lately killed deer placed over his head and shoulders, the stag not noticing he had only two legs.

But birds are the reverse. Ear and nose count for nothing compared with the eye of our hawks, gulls, and even less wary birds. Ducks do fail more signally to tell things that are dangerous by sight, but it seems to be obtuseness in the process of their cerebration and not keenness in recognizing. Like many men they don't act quickly enough.

A strange mistake in instinct our migrating ducks always make when it is foggy. They never seem to escape it. They come south along the coast for full 600 miles, flying close to the headlands. When they have gone 580 miles they pass Cape St. Lewis, and a wide, deep bay opens up with only the narrow south side of the bay between them, and the Straits up which nearly all the ducks are bound. As sure as ever a northeast wind blows, and there is too much fog to see across the inlet, practically every single flock will turn up the bay evidently mistaking it for the Straits. They are unwilling to rise and cross the land, I presume for fear of losing their bearings, so they follow the shore right

THE SUMMER HOUSE OF A FISHERMAN IN LABRADOR MADE OF TURF AND SODS

These houses are abandoned to their fate and allowed to fill with snow and ice; the people just clear this out and use it again next year. It gets welded together. White shells are used on the floor. These particular men own no schooner of their own to fish from, so take passage on a friend's and fish in small boats from the land.

XUM

SMALL SCHOONER PUSHING "DOWN NORTH"

The iceberg and the floe-ice show the dangers and the fearlessness of the men. These vessels are only 2½-inch planking, and every year some are sunk by the ice going through their sides. It is remarkable how few lives are lost, however. The pieces free are used as rafts till another vessel comes to the rescue.

around, passing between some islands and the southern cape.

So regularly is this the case that every northeast wind in the fall, without exception, a crowd of gunners line this tickle or strip of water between island and mainland, fire at random into the passing birds, and share equally the victims that fall. It is worth any one's while to join this company once, if only to see the arquebusses and almost "culverins" that some of these men produce and fire out of.

Their dogs, too, are a wonderful sight retrieving in these breaking seas, and climbing back against the back wash up these smooth-worn cliff sides. Only native dogs can stand it. My English retriever and spaniels are forced to confine their attention to the little piles of birds that soon grow up behind each sportsman, which with skill worthy of a better cause they steal and bring to mine.

For home consumption, however, the seals are most valuable, their skins and fat forming a marketable commodity of no mean value. When seals "strike in" plentifully it is the easiest way in the world to get rich, for it means that this source of wealth just comes to your door and drown themselves in your nets ready for your use.

Certain headlands are far better than others for this purpose. These are situated generally close to great turns in the land, as if the seals under water steered by the coast exactly as the birds do above. The analogy is made closer by the stupid way so many trim into one or two wide blind bights near the corner,

HEAD OF A WHALE, SHOWING THE BIG BARNACLES THAT GROW ON THESE CREATURES, AND ALSO RELATIVE SIZE OF A MAN AND A WHALE'S JAWS

exactly as if they had lost their way, a good instance being L'Anse Amour Bay, behind Forteau light-house.

The other great way to catch seals is known as ice hunting, and means following the whelping herds out on to the drifting floe ice, which is done either in large vessels or with light punts hauled over the floe from the neighboring land, or simply by venturing out on a run and chancing getting back to land again.

Labrador seals are real seals, and not the fur-bearing "*Otaridæ*" of the Pacific. Our largest, the hoods, are of immense size and height, and by no means to be carelessly approached when with their young. They will then show fight very readily, and many a poor old bull has come by his death from a rifle just to enable the murderer to steal the pelt of his baby that he was defending, his own body being left, after all, as being too heavy to take.

Their strength is well shown by there being found in their stomachs shells that do not exist less than 90 fathoms down, at which depth they must withstand a pressure of eleven atmospheres, while puny man, with all his apparatus, has not been able to descend thirty fathoms. Specially provided for spring boot bottoms are the *Phocæ barbatæ*, or square flippers, their skin being very thick and water-tight, and almost hairless. Of any and all these the meat can be eaten, and the fat used for fire and light.

That a young seal can rival the fatted calf on his own ground is shown by the fact that a white coat, or Kotik, of 38 inches long will have an immodest waist of 34 inches round.

Excellent as their skins are always for sleeping bags, canoes, tents, harnesses, etc., for clothing, in cold weather they cannot touch the cured caribou hide. In mild weather the seal hides are, as might be expected, much more water-tight, except when tanned, which we do by letting the skin "tint" till the hairs can be scraped off, and then soaking them in the boiled bark of our fir trees.

The soft chamois-like, cleaned skin of the deer makes clothing impenetrable to wind and weather, while the gloves and moccasins, being soft and mobile, are far warmer than the Labrador seal. So important a point in keeping warm is this mobility of the boot that in really cold weather there is a perceptible difference between a doe-skin moccasin and one made of an old stag, the thinner doe-skin being much warmer.

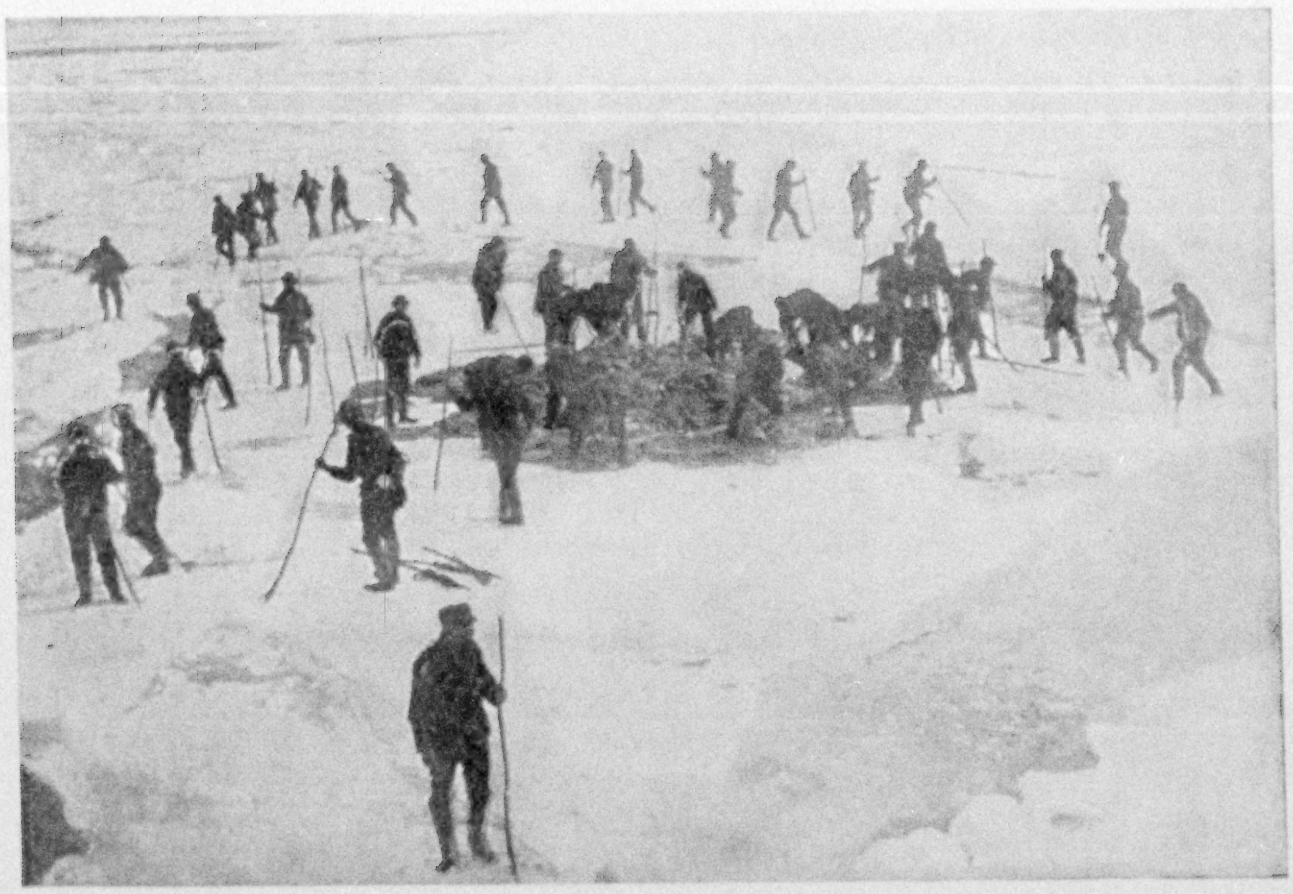
These deer are in great abundance still, and are still a staple article of diet and clothing, and even tent covers, with all our northern folk. The softened skin is generally brought out by our Indians and sold by the pound. They also bring out what they call parchment—that is, skin with the fat left in and the hair removed. This is used for filling snow-shoes, and is often sold by them cut all ready into "babbage," and rolled up into balls like string. The winter skins of deer killed by Eskimo are invariably used as bed spreads, the close, thick hair forming the best insulator possible from the cold ground.

When old or superabundant, these are exported to Germany, where with true Teutonic economy they are used for station mats till the hair is all trodden off, after which they become white buckskin gloves for the immaculate guards of the German Emperor.

That these deer can obtain in such quantities in spite of their numberless enemies, human and otherwise, proves what an immense industry is possible in raising domestic reindeer for their meat and hides. I have just heard from a doctor friend in Alaska, whose herd of 70 in 1902 has become 490 in 1909. My own herd of 250 in 1907 has become nearly 600 in 1909.

Flies are, strangely enough, really the worst enemies of the deer. There may not appear a single fly mark on a deer one kills, and yet among many hundreds of skins I never yet saw one skin that has not from 100 to 1,000 holes in it bored by the grub of the hornet-like fly we call "stout," while it is safe to bet that you can never kill a caribou without finding eggs, chrysallides, or the maggots of these flies lying among the ethmoid cells,

The sealing industry is carried on in March and April, when the Arctic ice comes south in vast fields. On this the Harp and Hood seals whelp. The big steamers, 22 in number, force their way through it, collecting and killing the helpless young. This is the ship's crew hauling sealskins with fat on to their ship.



A SEALING CREW "PANNING SEALS"

In this case the seal pelts are all massed together. Flags denoting to what ship they belong are fixed up on the heap, and the ship endeavors to pick up all her "pans" as opportunity offers. Often she never finds them, and so much waste occurs many times; also another crew comes along, removes the flags and annexes the seals.

or soft bones, far up in the nose and right against the base of the skull.

Wolves in Labrador are not very plentiful, judging from the quantity of skins sold annually at the various fur-trading posts, but they are naturally the relentless foe of the reindeer, whom they always follow till they kill. Of all the tragedies of life that appeal to me as pathetic in Labrador, none equals the wearing down of a gentle deer by these grim shadows of death. To know, as they must, that a wolf is on their track, and that there is no defense against him, no safety night or day, must be a prolonged nightmare besides which the pain of being torn to pieces alive by a hawk or eagle is an easy death.

A deer at bay, standing on his hind legs, makes an excellent fight with his enemy. Not only have trappers told me of scenes of this kind they have themselves witnessed, but I saw my own largest Eskimo dog twice knocked head over heels by one of our own tethered reindeer stags that the brute was endeavoring to kill.

Black wolves, or nearly black ones, are occasionally killed on our coast. I know of no one who ever saw a white one on our coast except the author of "Northern Trails." Among other animals of value, the black and silver fox rank easily first.

No fur can be said to have a standard value; the range is immense. Five years ago, on the coast, Patch foxes fetched as high as $30.00 apiece, and the best lynx skin only $3.50. Today the Patches are worth $8.00 to $10.00 at very best, while the lynx are worth $25.00 to $30.00. I have bought sables on the coast at $3.00, and a year or so later at $30.00. Today they are down again to about $10.00. The biggest range is naturally in black and silver foxes, which I have known fetch once on the coast $900.00. On the

ESKIMO GIRLS OF OKKAK, LABRADOR

CHARTING OF LABRADOR

Governor Sir Wm. MacGregor at the theodolite; Mr Gould, of Bowdoin University, acting secretary. This is some of our volunteer work

other hand, I have known a trapper paid $40.00 in trade (value about $20.00) for a fox which fetched $700.00, or £140, in the market.

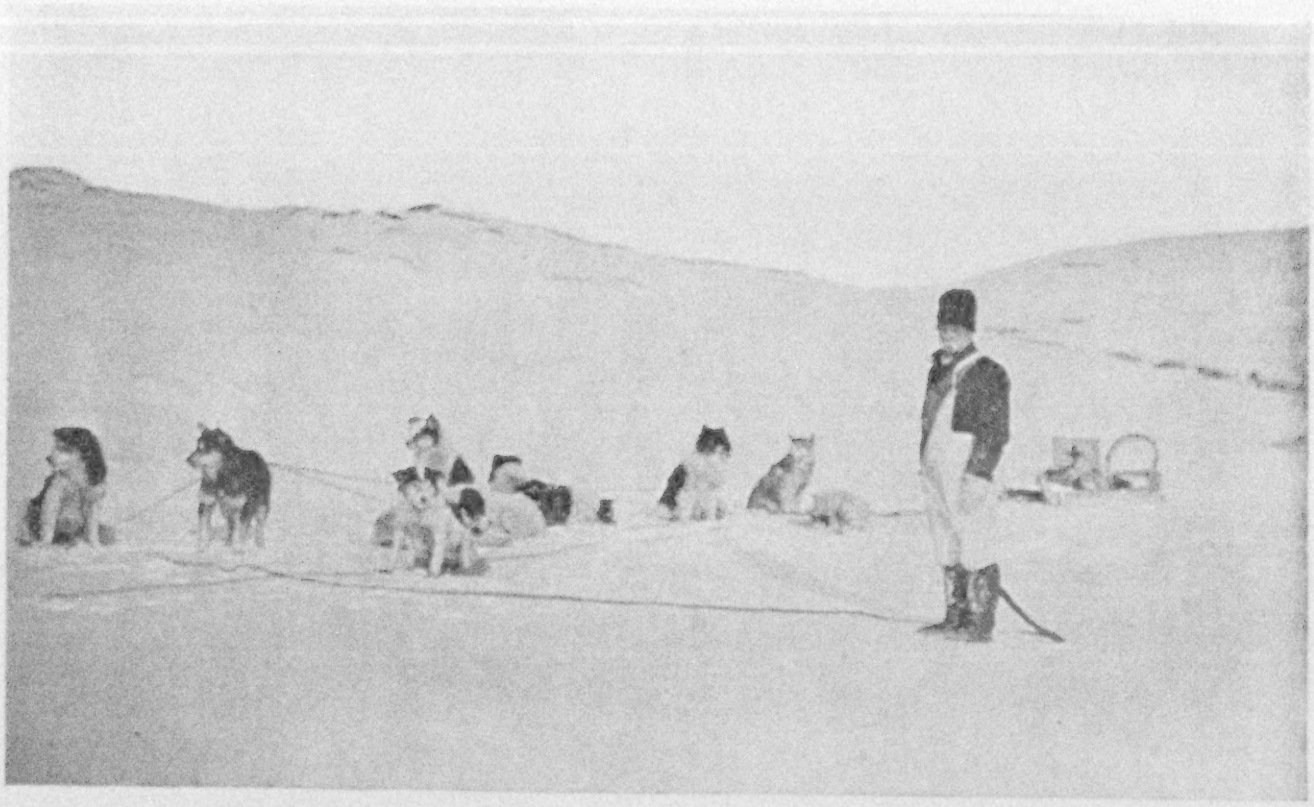
I have tried breeding foxes for five years, but without success. My "parks" were close to the houses, and too much disturbed, I presume. But others have had good success, and I intend later to try again further in the country.

That black parents throw black pups is a fairly well-established fact, especially when the black parents are of the second generation. That black pups are sports of red parents, just as bitches have puppies of many hues, is also true. It is possible naturally for these black scions of red parents to throw back and have red pups. But with black grandfathers and mothers, the puppies are pretty certain to be black also. The feeding of these is no more difficult than that of any ordinary dog, and the offspring may be worth $1,000 apiece. Last year I saw dug out from an island four small foxes, all dark silvers. These had a black mother, but unfortunately the dog was not seen. I presume he also was dark.

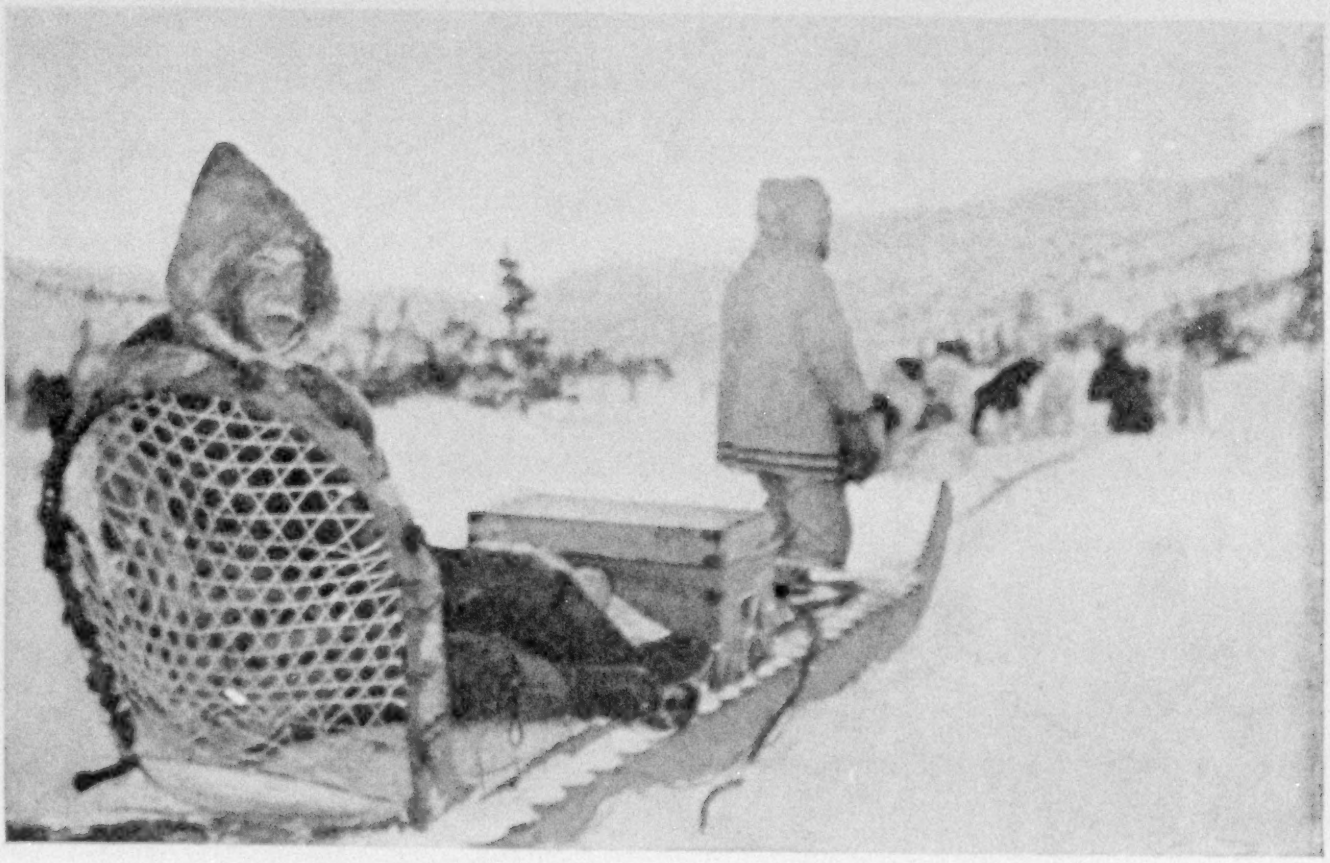
Other writers to the contrary, foxes of the same brood will kill and eat each other. I have known it three or four times.

Of bears generally I have little to say. We have our share of black and white. Both of these I have shot and eaten. The flesh of both is good and nourishing. The black bear, being a herbivore, as a rule tastes much like venison. He is, however, exceedingly fond of fish, and he not only poaches salmon pools, but comes to his death from this predilection, for it leads him to wander in search of the innumerable dead capelin, and to venture almost into the summer fishing settlements.

Many interesting tales about bears nat-



THE PHYSICIAN'S DOG TEAM AWAITING HIS RETURN FROM A WAYSIDE CONSULTATION



DR SEYMOUR ARMSTRONG GOING ON A SICK CALL: LABRADOR

XUM

SENDING SOUTH FISHERMEN WHO HAVE DIED AT HOSPITAL

It is the custom to preserve the bodies in salt when their own schooners call for them and carry them to their southern homes

urally exist on the coast. In the space at my command only one or two things, however, are worth noting. There can be little question that the polar bears, together with other animals, like caribou, and seals, and birds, possess a sense not inherent with men, viz: a direction sense. Whether it is magnetic or what, I do not know, but I am convinced it exists.

I have followed bear tracks for many miles, both along the coast and inland, and whether the course took him over flat snow fields, large lakes, through dense woods, or across wide arms of the sea, he always kept going steadily north. I refer now to stray bears that have followed the whelping seals too far south on the ice fields.

I met a polar bear once in the open Atlantic full three miles from the nearest land, just rolling lazily along north. If there were anything to be said for the evolutionary influences of natural selection, the polar bear should certainly be as amphibious as the seal in the near future.

But I must leave the animal resources of Labrador, and come to the vegetable wealth—a source of wealth that is by no means to be despised, as it is very easy to show. The red partridge berry or small cranberry, the blue hertz or bilberry, the yellow bake-apple or cloud-berry, the purple marsh-berry, with the red currant, the raspberry, and gooseberry, are all abundant, all easily preserved, and all grow without any effort on the part of the natives to sow, cultivate, or in any way improve them.

Sweep up a barrel full of the cranber-

THE FEW SHEEP HAVE TO BE SO CAREFULLY TENDED THAT THEY GET QUITE TAME

ries, and let them stand exactly as they are in a barrel, and they will be good all winter. Fill a barrel with the luscious bake-apples, pour in water and head up the barrel, and you have a delicious fruit all winter.

Nature, moreover, looks after you if you are too lazy to do this, and your children can run out in spring and pick cranberries and marsh-berries that have only sweetened for being under the snow all winter. The red of the cranberry is also a natural dye.

Of cultivated vegetables in Labrador the success depends on the shelter, natural or artificial, they get from summer frosts. In the bottoms of bays, carrots, peas, potatoes, lettuce, radishes, beets, etc., all grow in the open well.

Lord Strathcona developed a potato whose leaves crept on the ground instead of standing upright, and thus escaped these summer frosts. The Moravians gain the same end by covering the beds with rolls of brin or burlap, putting their potatoes to bed when they go themselves.

The leaves of our spruces make an excellent brew, when boiled with molasses and fermented, though the result is too intoxicating for an enemy of alcoholic beverages like myself.

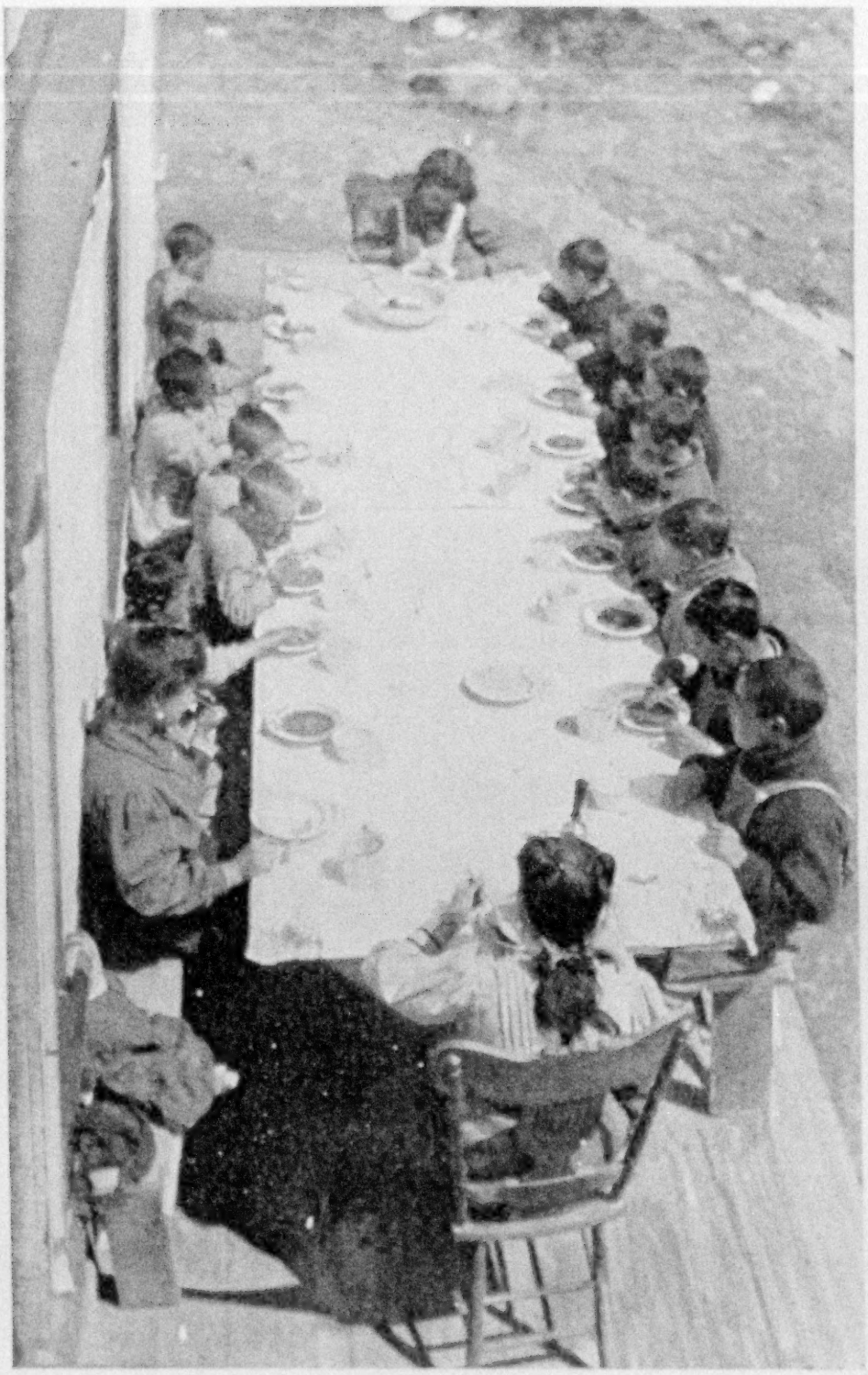
There is no need whatever for the scurvy that so generally afflicts some of the families every spring, except their own carelessness and ignorance. Now we seldom, if ever, see it. Mushrooms, of the varieties Russulæ and Boleti, grow in great abundance. Those who know, eat them freely fresh in summer, and, threading them on cotton strings with a needle, suspend them in the house and let them dry for winter. They swell out, and taste as good as fresh.

This is a commercial rather than an æsthetic article, and sooner than describe our innumerable flora of the small but bright sub-arctic varieties, whose abundance is well attested to by the fact that we have no less than 14 varieties of *Potentilla*, I will say a word about other possible industries for the country, though while speaking of flowers I should mention that the coveted Alpine Edelweiss has been introduced near Hopedale, and can now be found growing wild in the neighborhood. The immense future that lies before pulping in this country is, I think, very evident from the success attending Lord Northcliffe's great venture in Newfoundland, and by the fact that every acre of sea and land from the Straits to Hudson Bay has been applied for ahead, if not granted, for this very purpose.

The incalculable energy of the countless falls, including the Grand Falls of the Hamilton River, probably the third largest in the world, and second only to the Victoria Falls in height, is an asset which the future will be unable to overestimate. Now that chemistry stands on the very verge of a synthesis of atoms, and a new world seems to lie at our feet if sufficient energy is procurable, these hitherto unappreciated riches are beginning to excite attention. I have had already inquiries as to the feasibility of bridling these falls for the purpose of collecting nitrogen from the air for fer-

PACKING WITH DEER IN SUMMER: LABRADOR

SOME OF OUR REINDEER



A BATCH OF MY LABRADOR ORPHANS

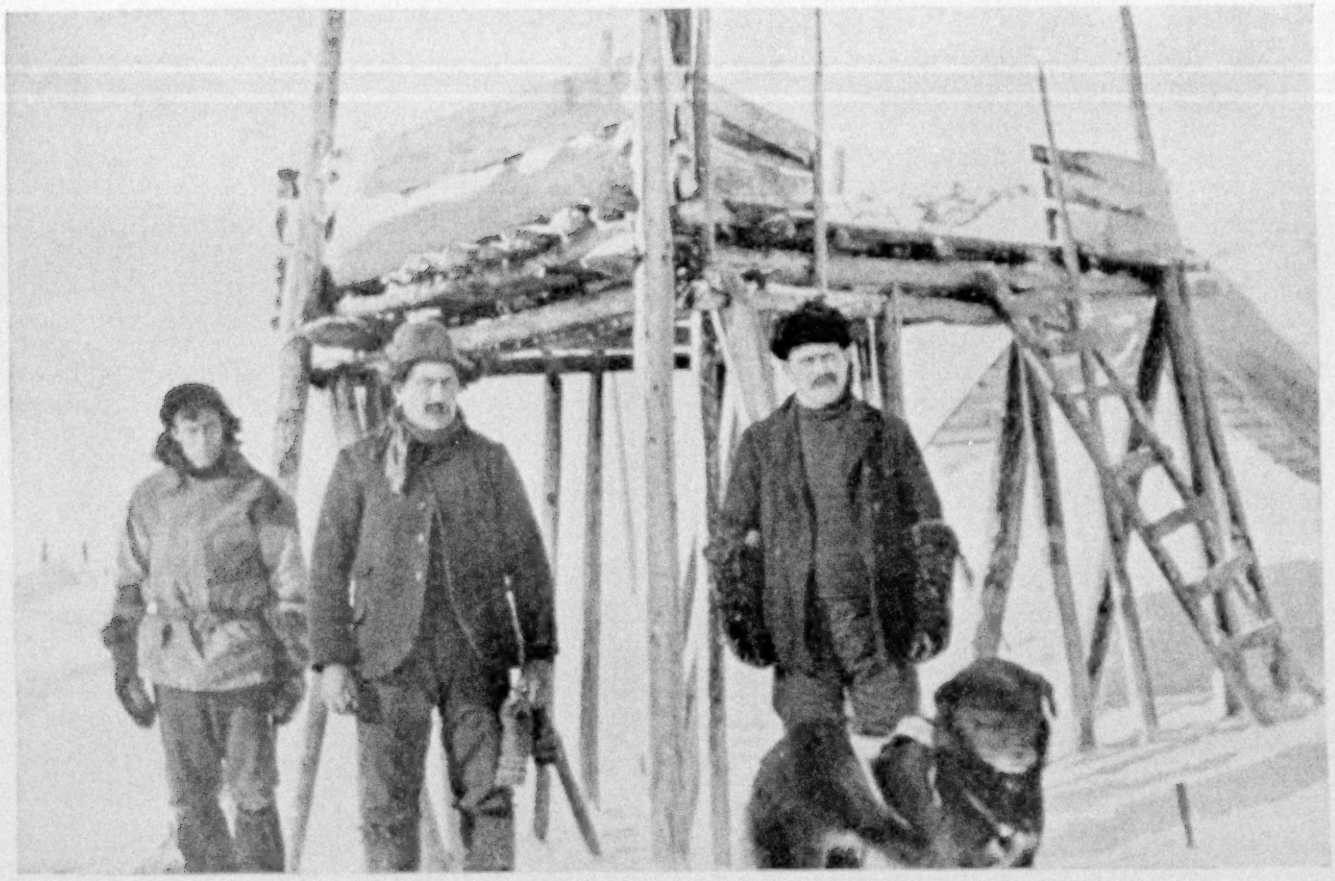
Open-air treatment for orphans

tilizing purposes. It is well known that the world supply of nitrates is giving out; that wood as fuel, and even coal are rapidly diminishing. Here lies one immense source of wealth that even the dull eye of a twentieth century scientist can foresee.

In our vast bogs lie supplies of peat that are almost inexhaustible; only these last few years has industrial chemistry turned its attention to these natural resources. All round this country the little settlements are bare and denuded of the beautiful evergreen trees given for their protection and for preserving animal life, just because of the ignorance of the heating material lying in the unused bogs, which instead of being injured would be improved by being used as a fuel supply.

The vast area of ledges, which run along our east coast, produces in places immense quantities of various seaweeds, which the storms pull up and fling at our doors without our having to stir a finger. In Norway the ashes of these weeds, just burnt on the beach, fetch from $2.25 to $3.75 a pound, and bring to the country as worked now $150,000 a year. Nature seems to make special provision for primeval-minded man, which as he increases in numbers is withdrawn, and so he is forced to put his wits to work and grow in stature whether he likes it or not.

In the spring, berries for us are ready under the snow, shell-fish in abundance under the harbor ice. Soon flat fish and round fish are veritably thrown on the beach, and can be dipped out with a hand net and can be speared with a straightened hook on a stick, or, as old Cartwright tells us, are at times so plentiful he could lie on the rocks and catch them by the tail in his hand. Trout we



"The man in the middle crossed the Straits of Belle Isle alone last winter, making three trips to and fro. He dragged a boat he built of canvas and laths, 7 feet 6 inches long, 2 feet 3 inches wide, and 13 inches deep. He had a little canvas cover, an oil stove, some food, and nearly 200 pounds of mails. He was out all one night in one of the worst gales we had, and drifted next day to land with his boat almost to pieces. He covered the bad parts of the laths with tin and went cheerfully on. He is a Labrador native, and his name is Ernest Doane."

can get in abundance through the ice all winter. Salmon and trout come walking into a net, only a few yards long, tied to your own wharf head.

Hares—well, I shot four in a couple of hours yesterday behind my house in this now growing settlement. Partridges—*i. e.*, willow grouse—well, my larder is stocked with them hanging from hooks that were shot last fall. I have known an Eskimo to kill 500 of these partridges by the simple process of flicking off their heads with his dog whip. Meanwhile there is another equally guileless and dainty variety, called spruce grouse, who sit on a bough while you go and slip a noose over their head, not requiring even the expense of ammunition.

I have not room here to write more of the native races that the white population are now displacing. Like all ignorant people of all races they are the cause of their own undoing. The indiscriminate cohabitation, and even marrying, is one serious factor in their downfall. Here are two cousins, each of which marries the other's daughter, so that each became the other's mother-in-law, sister-in-law, and cousin; and here, again, is another, who married his own son-in-law's daughter, so that she became, I presume, her own step-grandmother and her own father's mother-in-law.

Their lack of interest in sanitation or any health laws, and contempt for any prophylactic precautions, is simply phenomenal. I have taken away the clothing of a patient with typhoid and a high temperature to keep him in bed, and found him outside the house next day naked, while their passion for "something to rub" or "something that will

stick on"—*i. e.*, a plaster—would make the calling of a medical man impossible on this coast if seal and bear oil was not as acceptable to them as olive, if oakum and moss did not serve as well as padding for dressings, and if coniferous resins were not adhesive. Plain board beds seem to give rise to no bed-sores through their thick acclimatized skins.

An antipathy to anæsthetics would have rendered more than one operation impossible had it not been for their stoicism and inordinate pride in being the center of attraction, which, as a superior mental emotion, led one young woman to grin while I amputated her frost-bitten toe, just because the tent was filled with an admiring audience. It has always struck me that they would be good material for Christian science.

With dog stories and winter travels the coast just abounds, and many a night by a log fire I have listened to the most exciting yarns of old hunters. But here there is no room for these. Suffice it to say, I have tried most sports that young manhood in civilization affects, and I have yet to find a match for our winter traveling.

There are lots of poor, yes very poor, people in Labrador. I have seen nakedness and starvation every year that I have been here. That is why we are here, not merely because these are miserable people, but because those people we believe need not be miserable or starving or naked. It is true a man's work must in spite of him crystallize often enough into temporizing methods. It is the same in our professional and every other work at times.

But we believe in the country, and we believe in the people. The former can, we are convinced, evolve a worthy contribution to the human race—a people not enervated and enfeebled by the soft things of life or by artificial conditions. We hope to be factors in hastening the process.

It has been suggested to change the whole climate of Quebec by damming the Straits of Belle Isle and shouldering off the arctic current. Nothing is impossible. The north side of the Straits is an admirable spot at present for a penal settlement, and material is not lacking with which to fill up that shallow strip of water. A railway can be run with ease to the bottom of St. Lewis' Bay, and bring in its train increasing comforts and increasing facilities for living. But without these we have been privileged ahead to see the dawn of a better day, and we only stand grateful to Labrador for the opportunities it has afforded us.

# NOTES ON THE DESERTS OF THE UNITED STATES AND MEXICO

*Some desert plants have cisterns which they fill with water against the days of drought, just as the ant stores its cellar with grain and choice morsels in preparation for the days when it is imprisoned by the rain and snows of winter. Another species will spend many years to gather the force to send upward a single stalk of flowers and then immediately die as if contented, after years of labor, to perpetuate itself by this single blossoming. Other plants have developed hairy coverings and resinous coatings which protect them from the burning sun's rays and also prevent the evaporation of the water they have secreted. These and other wonderful characteristics of desert vegetation which have long excited the wonder and attention of botanists are now being systematically studied in the desert itself by the plant specialists of the Desert Laboratory, at Tucson, of the Department of Botanical Research of the Carnegie Institution of Washington. It is believed that these researches will result in much new information as to the origin and physiology of plants, and that they will also ultimately be of much practical assistance to the agricultural interests in sections where the rainfall is slight. The following article has been abstracted by the Editor from a recent publication by the Director of the Department of Botanical Research, Dr Daniel T. MacDougal, "Botanical Features of the North American Deserts." The illustrations are from this publication and are from photographs by Dr MacDougal.*

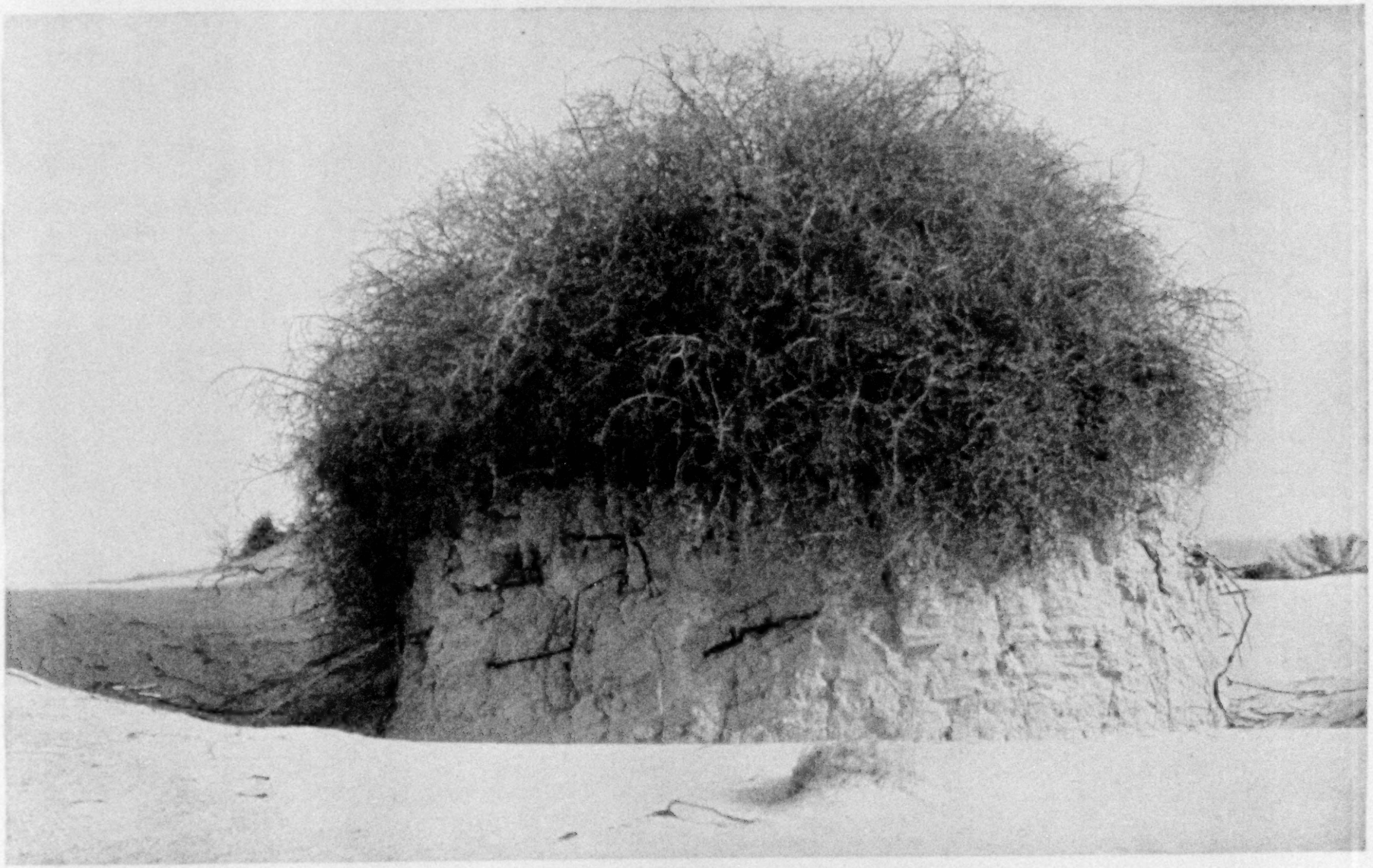
TUCSON has a climate of a thoroughly desert character, and a flora, including mountains and plain, rich in species and genera. In addition to its situation in the heart of the desert of Arizona, it is centrally located, both as to position and transportation, with reference to the deserts of Texas, Chihuahua, New Mexico, California, and Sonora. The city has a population of nearly 22,000. It is situated on one transcontinental railway, and has good connections with others, as well as shorter lines to various regions of interest.

The business of the city and the conduct of its municipal affairs are largely in the hands of progressive Americans. The elevation of Tucson is 2,390 feet, while the highest of the mountains that surround the plain in which the city lies, the Santa Catalina Range, reaches about 7,000 feet higher. The University of Arizona, with its School of Mines, and the Arizona Agricultural Experiment Station are located at Tucson.

Not the least of the advantages of Tucson as a center for the activities of the laboratory is the broadminded comprehension of the importance of the purposes of the institution evinced by the citizens, accompanied by an earnest desire to coöperate in its establishment. This appreciation was expressed in the practical form of subsidies of land for the site of the building and to serve as a preserve for desert vegetation, the installation and construction of telephone, light, and power connections, and of a road to the site of the laboratory, about two miles from Tucson. The monetary value of these concessions is by no means small, and is much enhanced by the generous spirit in which they were tendered. This spirit of hearty coöperation has animated every organization in the city, and has enabled the laboratory to gain control of a domain of 860 acres, of the greatest usefulness for general experimental work.

### IN THE "JOURNEY OF DEATH"

Extending northward for nearly 100 miles from El Paso is the noted Jornada del Muerto (Journey of Death), which has a width of 30 to 40 miles. It formed



COLUMN IN THE WHITE SANDS OF NEW MEXICO

The shade and mechanical action of the roots of the three-leaved sumac have prevented a section of a dune from being moved by action of the sun and wind, and it remains in columnar form (see page 693)

a portion of the route connecting the earliest settlements along the Rio Grande, and here the traveler was compelled to leave the stream far to the westward, in its deeply cut, inaccessible canyon, and toil for two or three days in the burning heat without water, except such as might be carried. It was for three centuries one of the most menacing and hazardous overland journeys to be encountered in the American Desert. Recent investigations, however, have shown that the region traversed is in reality a basin, and that water is to be found, as in many other deserts, within a reasonable distance of the surface.

Beyond lies an equally remarkable desert, the Otero basin, which is the bed of an ancient lake, and is noted for a great salt and soda flat, a salt lake, and, most striking of all, the "White Sands," an area of about 300 square miles covered with dunes of gypsum sand rising to a maximum height of 60 feet.

The surface of the dunes is sparkling white, due to the dry condition of the gypsum powder, but a few inches beneath it is of a yellowish or buff color and is distinctly moist and cool to the touch, even when the air is extremely hot. The smallest particles may be crumbled in the fingers, and as a consequence the dunes are solidly packed.

The most characteristic plant of the dunes is the three-leaf sumac (*Rhus trilobata*), which occurs in the form of single hemispherical bushes 4 to 8 feet high, the lower branches hugging the sand. The plant grows vigorously, the trunk at or beneath the surface often reaching a diameter of 3 inches. The binding and protecting effect of this bush is often shown in a striking manner when in the cutting down of an older dune by the wind a column of sand may be left protected above from the sun by the close covering of the branches and leaves, and the sand in the column itself bound together by the long penetrating roots. One of these columns was about 15 feet high from its base to the summit of the protecting bush and about 8 feet in diameter at the base (see page 692).

A curious fact brought out in the exposure of the underground trunks of this plant by the shifting of the dunes is the abundant exudation of a pale amber gum with the characteristic aroma of the crushed twigs. This, mixing with the sand, forms hard, honeycombed masses sometimes 3 inches in diameter.

A marked peculiarity of the White Sands is that a cottonwood is occasionally found in the lower dunes, reaching a foot in diameter, but seldom more than 15 feet in height; yet at the same time not a mesquite was seen. The mesquite is a tree requiring less moisture than the cottonwood. Apparently the presence of an excess of gypsum is prejudicial to the growth of the mesquite.

The bottoms among the dunes have a dense vegetation as compared with that of the dunes themselves. It is characterized especially by the presence of a grama grass (*Boutcloua*), forming almost a turf, and by frequent clumps of *Ephedra* of a grayish purple color at this season and with 3-scaled nodes. These bottoms usually show no sign of moisture, but in two places we found waterholes, the water so alkaline that the horses would not drink it at the end of their first day's drive.

The relation of *Yucca radiosa* to the sand dunes is unusually interesting. A group of four small yucca shoots standing about 3 feet high to the tip of the highest leaf was found upon the summit ridge of a 30-foot dune. We dug the trunk out to a depth of 14 feet. All four plants were from branches of the same trunk, the lowest branch arising about 16 feet from the base of the dune; the main trunk and the branches bore marks of rosettes of leaves at intervals all the way to the lowest point reached. The trunk sloped in the direction in which the dune was moving. The yucca originally grew on the plain, was engulfed by the sand, and gradually grew through each successive layer of sand that drifted over it until the summit of the dune was reached. In the vicinity, at the rear of the dune, were other long trunks partly denuded by the passing of the dune.

XUM

### THE PLANT THAT OWNS A CISTERN

Probably the most extraordinary product of the Sonora Desert, west of Torres, Mexico, is the guarequi (*Ibervillea sonoræ*), a tendril-bearing plant whose inordinately thickened root and stem base lies gray and half exposed upon the ground beneath some trellising shrub (see page 696). These tuberous formations may be seen during the dry season lying about wholly unanchored, as the slender roots dry up with the close of the vegetative season, which lasts but a few weeks.

In February, 1902, some of these tubers were taken to the New York Botanical Garden, and a large specimen not treated in any way was placed in a museum case, where it has since remained. Annually, at a time fairly coincident with the natural vegetative season in its native habitat, the major vegetative points awaken and send up a few thin shoots which reach a length of about 2 feet only, since they do not obtain sunlight. After a period of a few weeks, they die down again and the material in them retreats to the tuber to await another season. Seven periods of activity have thus been displayed by this specimen with no apparent change in its structure or size. It does not seem unreasonable to suppose, therefore, that the guarequi is a storage structure of such great efficiency that water and other material sufficient to meet the needs of the plant for a quarter of a century are held in reserve in its reservoirs.

The guarequi is reputed locally to be very poisonous, but repeated tests by Dr William J. Gies and Miss Julia Emerson, with living material, hot and cold water extracts, and alcoholic extracts, fail to produce any results with the various animals used as test objects. It is quite possible, however, that the living vines or the fruits might yield substances upon which the prevailing opinion is based.

The morning-glory (*Ipomœa arborescens*) is here a tree 20 to 30 feet high, with smooth chalky gray trunk and branches. During February it is leafless throughout, while its large white flowers open one by one on the ends of the naked branches. From its white bark the tree is sometimes known as palo blanco, and from the gum or resin, which exudes from incisions made in it for the purpose and which is used as incense in religious ceremonies, it is called also palo santo.

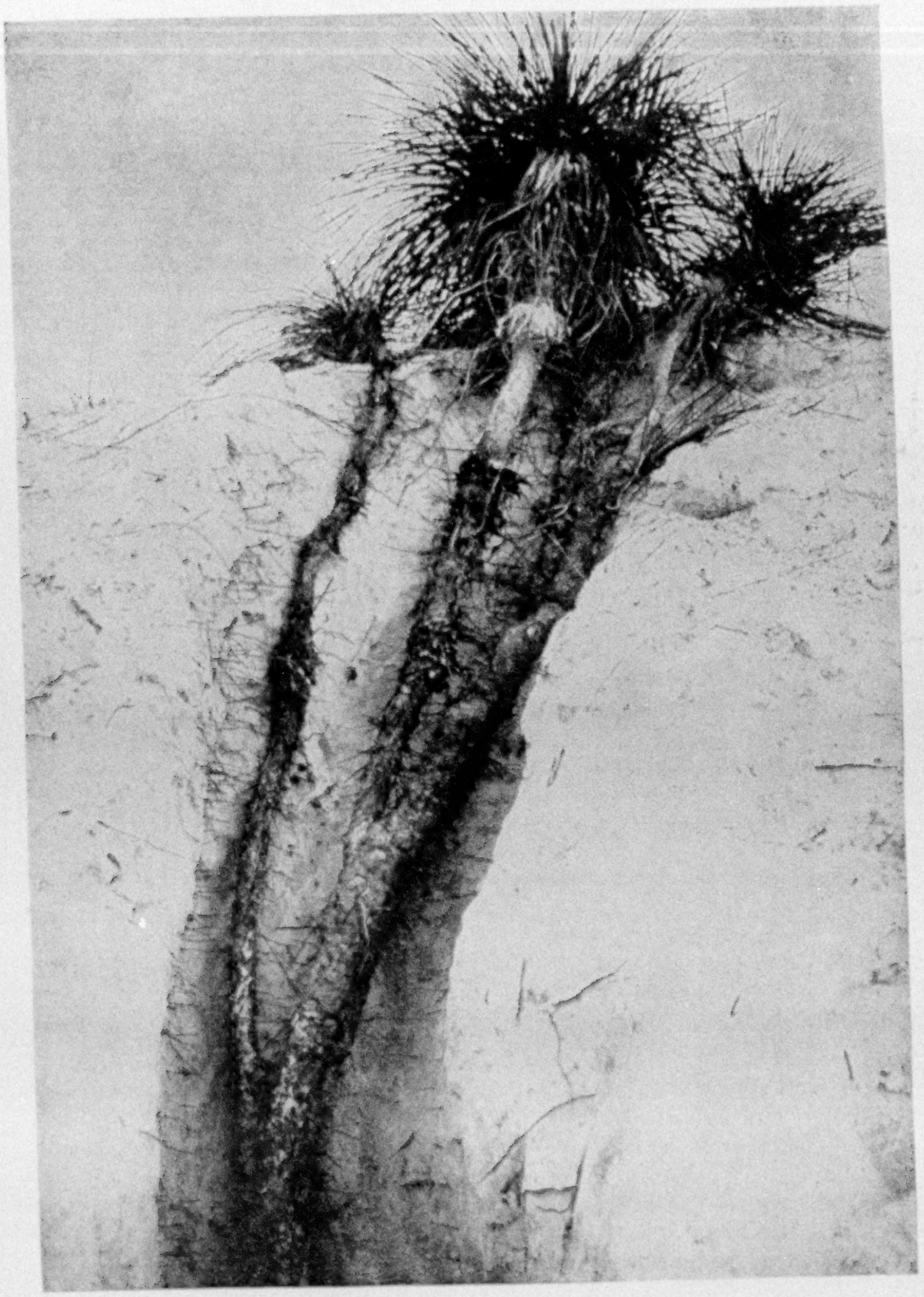
### WONDERFUL CACTI THAT STORE HUNDREDS OF GALLONS OF WATER

One of the striking features of the Tehuacan Desert of southern Mexico is the extreme localization, or strictness of colonization, exhibited by many species which are found to cover an area of a few square yards, the face of a slope, the crest of a cliff, or the floor of a barranca, with no outliers and with the nearest colony perhaps many miles away.

The Cactaceæ are more abundant here than in any other part of the world yet visited, several of the species being massive forms, which constitute very prominent features of the landscape.

*Cephalocereus macrocephalus* (see page 698) is a tall species of the massiveness of the sahuaro, and like it having a central shaft bearing numbers of branches which are more closely appressed. It was seen only along the cliff near the Rancho San Diego, along the eastern edge of the valley. *Pilocereus fulviceps* (see page 699), of more general distribution on slopes, has a series of branches, in many instances 40 or 50 in number, densely clustered and arising from a short trunk, which barely rises from the ground before it branches.

*Echinocactus* was represented by a half dozen species, of which one, *E. grande* (see page 701), is undoubtedly the most massive of all the genus, being as much as 8 or 9 feet in height and 30, or even 36, inches in thickness, which, with the many convolutions of its surface, makes it a very grotesque feature of the scenery. The young of this species are characterized by very striking cross-stripes which disappear with age. Upon testing the pith to compare the watery content with the northern species, it was found that so much calcium had been taken up and stored in the form of calcium oxalate or



*Yucca radiosa*

Which has elongated its stem sufficiently to keep its crown above a moving gypsum dune 30 feet high, the crest of which has passed it a few feet. The excavation has laid bare a trunk twice the ordinary length. White Sands of New Mexico (see page 693).

A REMARKABLE VINE, THE GUAREQUI (*Iberrillea sonorae*), WHOSE LARGE EXPANDED STEM-BASE SERVES AS A STORAGE ORGAN (SEE PAGE 694)

carbonate that the tissue was unpleasantly gritty when chewed, and that its crispness made it difficult to express the juice.

*E. flavescens* (see page 700) forms small heads in clusters, while in *E. robusta* colonies 10 or 15 feet across, making mounds 2 or 3 feet high, include hundreds of heads.

No systematic account of any desert is to be found in which the storage function appears so highly developed and by so many species. Of course, all of the cacti exhibit this feature in a very marked degree, and a single plant of *Pilocereus fulviceps* may retain several hundred gallons of water. The large stems of *Yucca*, which is a prominent member of the flora of the slopes, function to this purpose to some extent, while the fleshy leaves of *Agave marmorata* and other species, and of *Hectia*, are essentially storage organs for reserve food and surplus water. Here is also a *Euphorbia* and a *Pedilanthus*, with thick upright cylindrical stems, in which the storage function is made more effective by the possession of a thick milky juice.

The tree morning-glory (*Ipomœa*) has a soft, thick trunk, into which a knife may be easily thrust to the hilt, the tissues being highly charged with water and containing some reserve food material.

Perhaps of all of the plants which show this capacity, however, *Beaucarnea œdipus* is the most remarkable. This relative of the *Yucca*, like all plants of this group with narrow leaves, is known as "sotol," and has the bases of the trunks swollen in adult specimens to a diameter of 7 or 8 feet, the topmost branch not reaching a height of more than 25. This trunk has a truncate base resting almost upon the top of the ground, to which it is attached by a few slender roots. After death, the loss of water reduces the weight of the storage organ so much that a large plant may be easily toppled over as it stands.

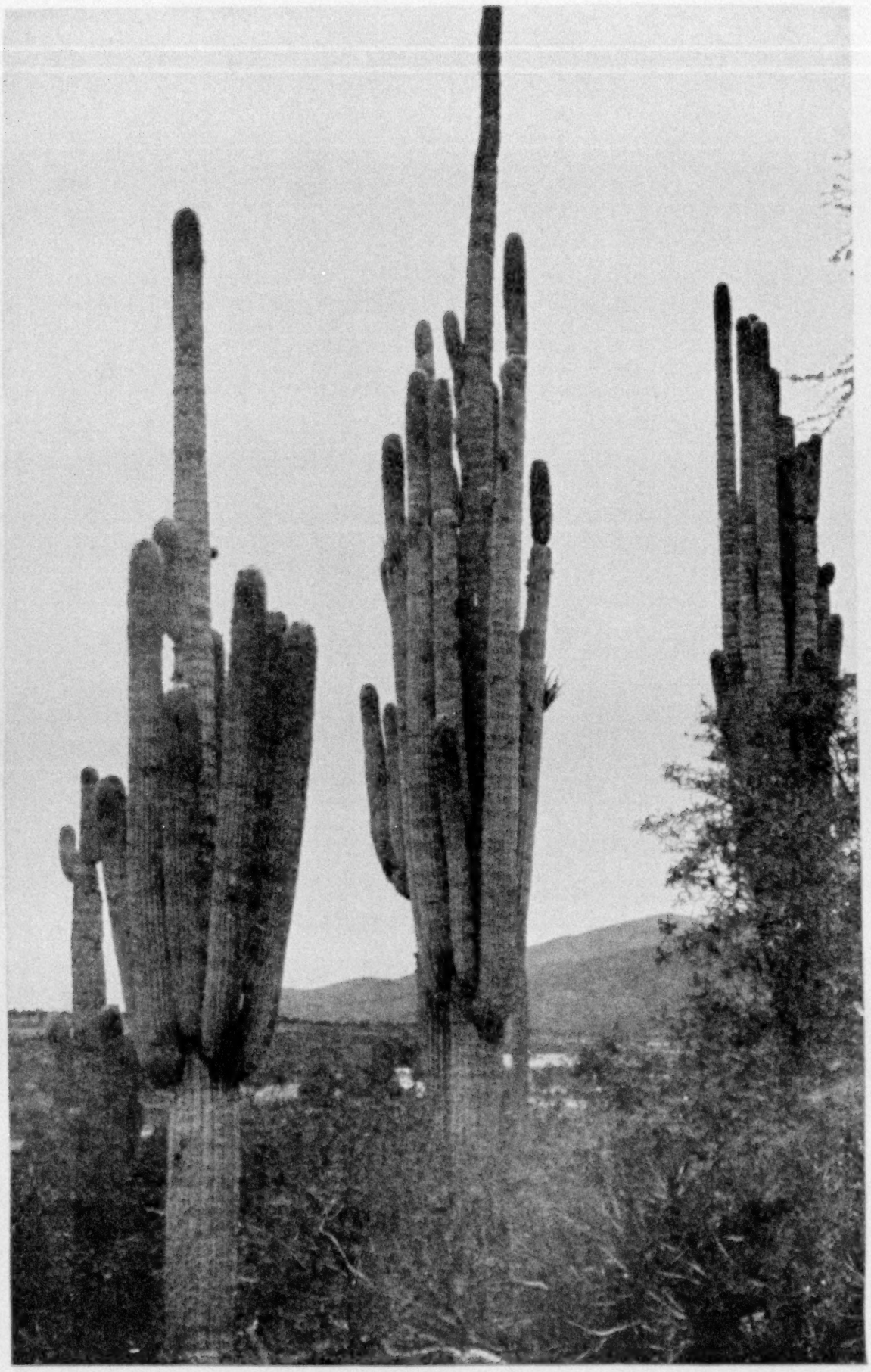
IN THE DESERT NEAR MITLA, MEXICO

As one proceeds to the ancient ruins of Mitla, 36 miles to the southeastward of Oaxaca, the aridity increases until in the vicinity of the hacienda of that name extreme desert conditions are found. The ancient structures here are indicative of a type of civilization characteristic of the desert, in which coöperation or communism was carried to as great lengths as it must have been in the pueblos of the northern deserts in America.

A short distance to the eastward from Oaxaca lies the village of El Tule, in which grow a large number of cypress trees (*Taxodium mucronatum*), one of which stands in the churchyard, and by the claims of local patriotism is the greatest in the world, while for a long time it has been cited as the oldest living. Both of these claims are incapable of actual proof, although the tree has much to justify an interest in it. Six feet from the ground it measures 154 feet in circumference, but it may be really two or three individuals fused together, as it divides into that many main branches within 50 feet. This tree has been an object of observation for more than two centuries, and on one side is a tablet, partly covered by the growth of the outer layers of the trunk, signed by the great naturalist, Baron von Humboldt, and probably placed there by his direction a century ago.

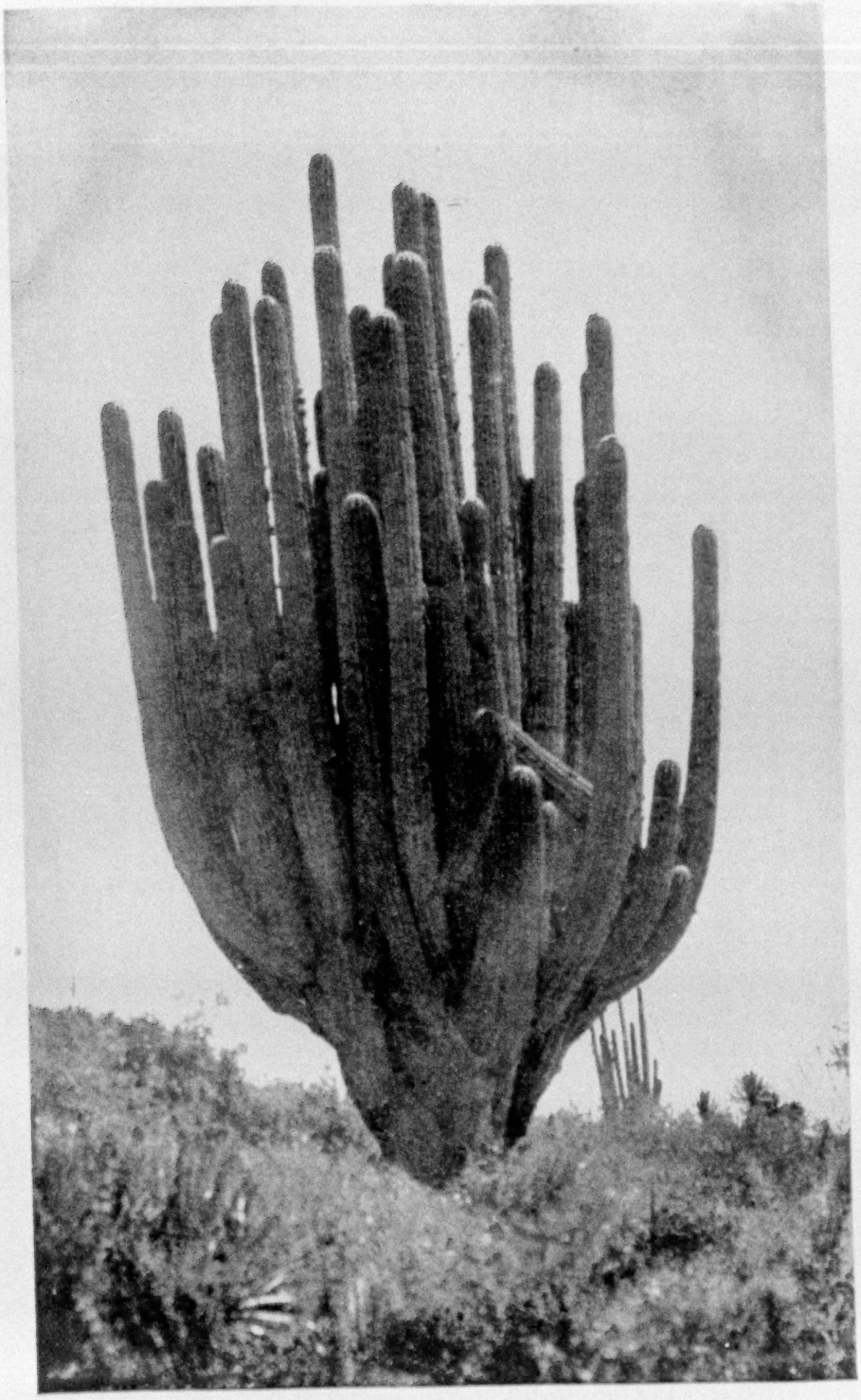
From El Tule to Mitla the way passes between fields illustrating methods of agriculture in an arid tropical climate. Not the least interesting of these features are the crops of maize of species either primitive or directly derived from one of the elementary species of *Zea*. The highway, especially where it passes through small villages or near a hacienda, is marked off from the fields and compounds by barriers of cacti grown in dense rows. Two or three species of *Cereus* and several prickly-pears are used for this purpose and also yield a valuable crop of fruit for the owners.

At Mitla the opportunity was offered for seeing the manufacture of mescal from *Agave*. Plants of several species and horticultural varieties of *Agave*, as well as of *Yucca* and *Dasylirion*, are uprooted at a time when the plant is about



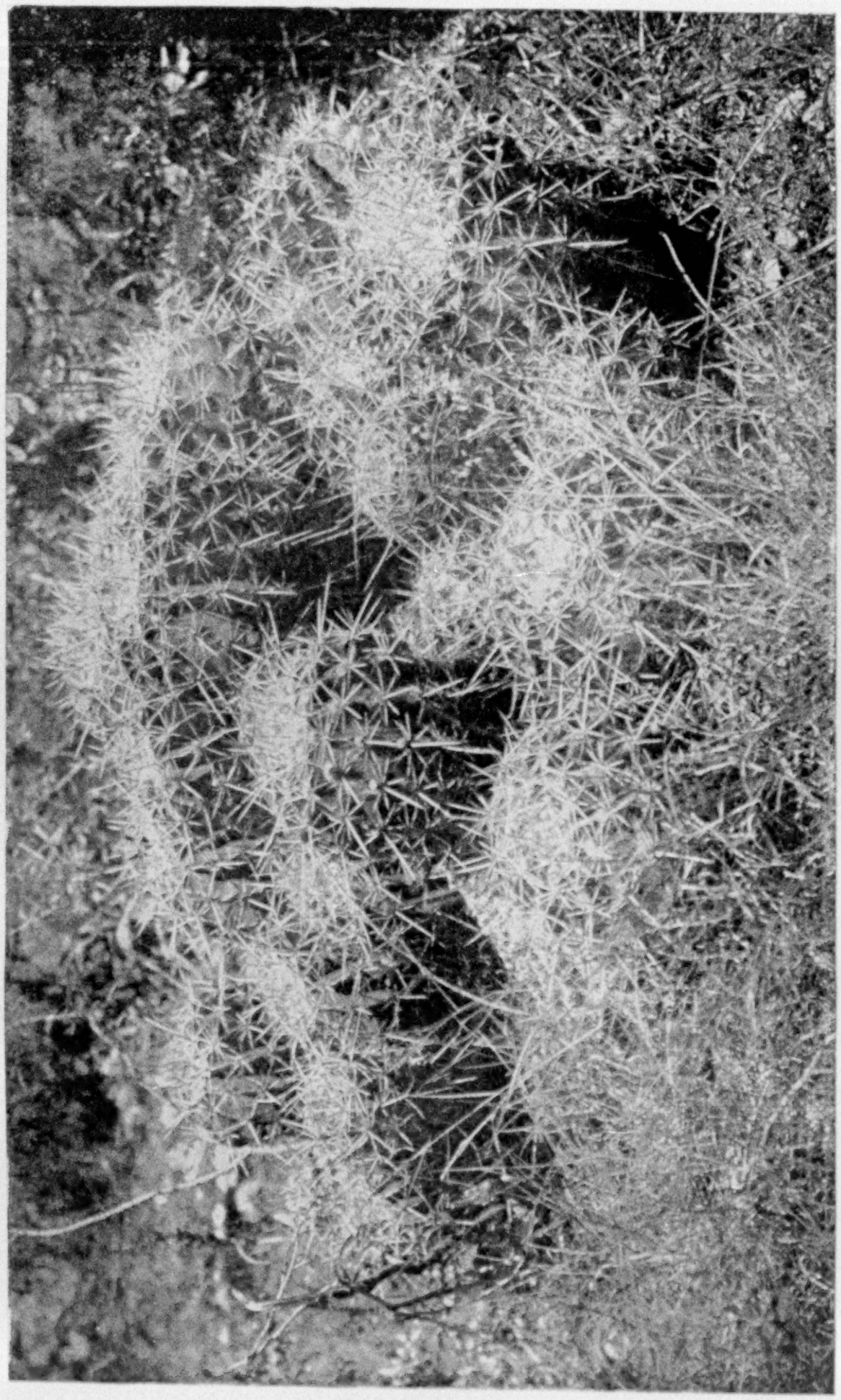
A TREE-CACTUS NEAR TEHUACAN (*Cephalocereus macrocephalus*)

An epiphyte, a bromeliad, is seen attached to the branches



A MASSIVE TREE-CACTUS NEAR TEHUACAN, MEXICO (*Pilocereus fulviceps*)

Several hundred gallons of water are stored in its fiber (see page 697)



*Echinocactus flavescens*: TEHUACAN, MEXICO

Another kind of desert cactus which also stores many gallons of water for the long dry months

*Echinocactus grande*: TEHUACAN

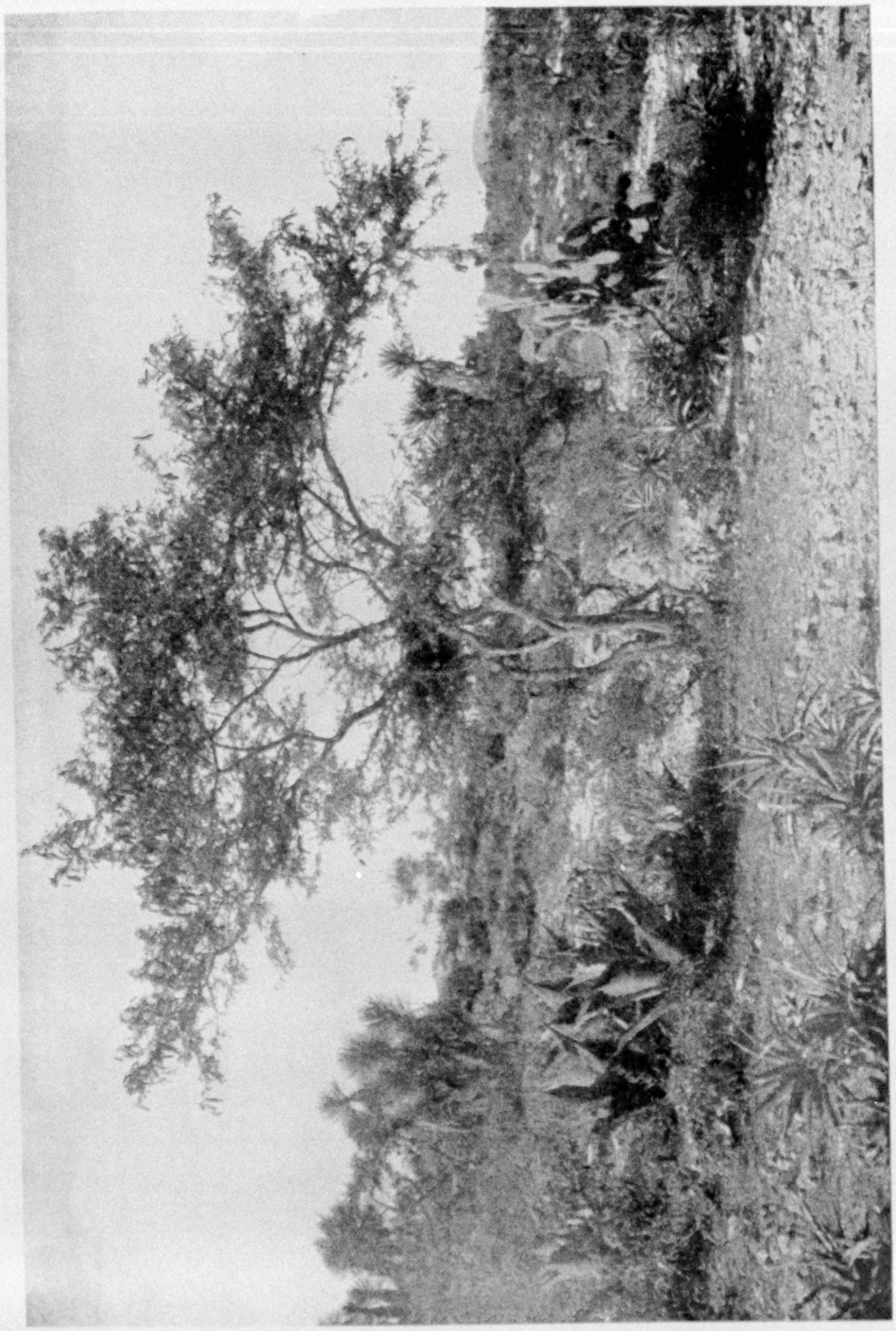
A plant of great age and maximum size (see page 694)

to send up its long inflorescence axis and is loaded with sugary substances. The leaves and roots are trimmed away, leaving a huge core in the case of the large agaves. A large pit is heated by means of a hardwood fire built in it, and after being cleansed of ashes and the remains of the fire the cores are piled in the cavity and covered, and allowed to bake slowly for two or three days.

Next the pit is uncovered and the cores removed to a large vat made by sewing the edges of three or four cowskins together and suspending them from a framework of rough branches. Fermentation is allowed to act upon the sugary material for a week or ten days, and then the unpleasantly smelling liquid is dipped out and put in the kettle of a rude still, the cap of which is connected with pipes cooled with water run in wooden conduits from a stream near by. The resulting liquor contains a mixture of several alcohols and is exceedingly fiery, being a true whisky of a desert people.

### TWO POPULAR THEORIES WHICH ARE ENTIRELY WRONG

The Colorado River cuts directly into the gravelly plain or mesa of the Sonoran Desert at four points on the eastern margin of its delta. At these places may be found within a compass of 100 feet the most vivid contrasts of rank swamp vegetation and water-loving plants having broad leaves and delicate tissues with the toughened, spinose, and hairy xerophytic forms of the desert. The presence of the moist area of the delta has but little effect upon the climate of contiguous arid regions, although a popular supposition to the contrary promises to be immortal. The relative humidity here is often as low as 17 per cent within 50 feet of the margin of the water.



GROUP OF DESERT VEGETATION ON LIMESTONE SLOPES NEAR EL RIEGO, TEHUACAN

Hectia, Agave, Yucca, Euphorbia, Opuntia, and a leguminous tree are to be seen

The armature of desert plants is often thoughtlessly cited as an adaptation by which these forms protect themselves against the ravages of animals. The presence of spines undoubtedly operates to prevent a plant from being eaten by animals, but the action of the animals has in no wise induced their formation by the plant. As a matter of fact, the fatality among desert plants by injury from animals is greatest in the seedling stage. For every prickly-pear that survives, tens of thousands of seedlings are eaten by rodents, and these seedlings are as unarmed as those of any other type.

### CHANGE OF CLIMATE

A change of the climatic conditions throughout the Southwest, and especially in the semi-desert region of Arizona and New Mexico, is marked everywhere by the evidence of a much heavier rainfall than we now have. River valleys in many cases show only dry gravelly or sandy beds which evidently were formerly occupied by continuous streams. The floods that once carved their way across the slopes or over the plains are no longer seen, at least not in the same volume as in former time. Even existing streams do not reach in times of great flood their former volume and carrying capacity. All tell of diminished volume, whether in the desert regions or in the regions of abundant plant-growth.

We may believe that the cause is extraterrestrial and cosmic, and a part of the great era of climatic changes giving to the earth the glacial era, and its gradual decay. We may believe that the era of greatest precipitation in the Southwest and elsewhere was coincident with the widest extension of the glaciers and that while the higher mountains were being loaded with snow, the lower slopes were deluged with rain or watered freely by the melting snows and enjoyed a verdure no longer possible.

### EXTINCTION OF THE GREAT MAMMALS

The fact of the existence and wide geographical range in Arizona of the great mammals, the mammoth and the mastodon, shows a very different condition of vegetation up to comparatively recent geologic time. The extinction of these giant herbivores may be best explained upon the theory of the desiccation of the region rather than by a change of temperature or increasing cold, as apparently was the case in Siberia, and may have been in the glaciated regions of California. A great change in the rainfall and the drying up of the slopes and mesas of Arizona must of necessity have caused a great change in the growth of plants, involving their destruction over great areas. It would appear that the extinction of the giant mammals and the disappearance of suitable vegetation for their sustenance proceeded together, and were due to increasing heat and dryness rather than to increasing cold.

We have ample evidence that in the Cretaceous era conditions in Arizona were favorable to forest growth and luxuriant vegetation. The coal-beds of Deer Creek near Saddle Mountain in Pinal County, described by Emerson, reveal such conditions.

Quantities of silicified tree trunks in the vicinity of Yuma and the prostrate forms of giant trees turned to stone in the Petrified Forest Park bear eloquent testimony to such forest growths and to destructive climatic changes in Tertiary time.

More recent evidence is found in springs surrounded by relics of vegetation, such, for example, as Andrade's Spring east of Tucson and on the right bank of Davidson's Canyon, where there is a thick accumulation of sphagnum with stumps of trees and, at the bottom, teeth of the mastodon.

The former existence in Arizona of a species of *Bos* of unusual size is shown by the discovery of enormous horn-cores in the gravels of the secondary or derivative slopes of the Santa Ritas at Greaterville.

### THE CACTUS FLOWERS AND PRICKLY PEARS

The greatest activity among the cacti is displayed by the cereuses and opun-

tias. The earliest of these in the vicinity of Tucson is generally *Echinocereus fendleri*, in which a few brilliant crimson flowers are displayed from the clumps of short, thickened, cylindrical stems late in March, and continue for a month, to be accompanied and followed by equally noticeable bloom of two or three other small species (see pictures, pages 705, 710, 711).

Chief of the group, however, is the great saguaro, the flower-buds of which develop as dense clusters on the portions of the apices of the stems most exposed to the sun, and have been seen to open on March 25. The whitish flowers each remain open but a short time, and apparently are pollinated by insects. A succession of them ensues, and although practically finished during May or June, yet belated buds open at various times, one having been seen as late as the middle of November. The seedy fruits mature in great quantity in midsummer, and are much prized by the Papagoes, who make much use of them in various ways.

The prickly pears, or opuntias, with flat stems, begin to make some growth of new joints and to push out flower-buds in March, and late in that month or early in April bloom in great profusion, the fruits maturing early and dropping to the ground. Fifteen or twenty species are native to the Tucson region, but the greatest confusion prevails as to their identity. Of the various desert plants, this group has been the subject of the most inquiry as to its possible economic utilization.

After a consideration of the various practical questions connected with open cattle ranges, it has been found that the best use of them for forage is made by growing or allowing to grow spinose species, from which the spines are burned when they are to be consumed by animals. This is now done with the plants growing in various places. Unarmed forms are subject to the attacks of so many animals that it is practically impossible to secure a crop without protecting fences. A few species are known in which the spines are very sparse. One of these, *Opuntia lævis*, occurs in the canyons of the Santa Catalina Mountains, but chiefly on rocks or in places inaccessible to grazing animals.

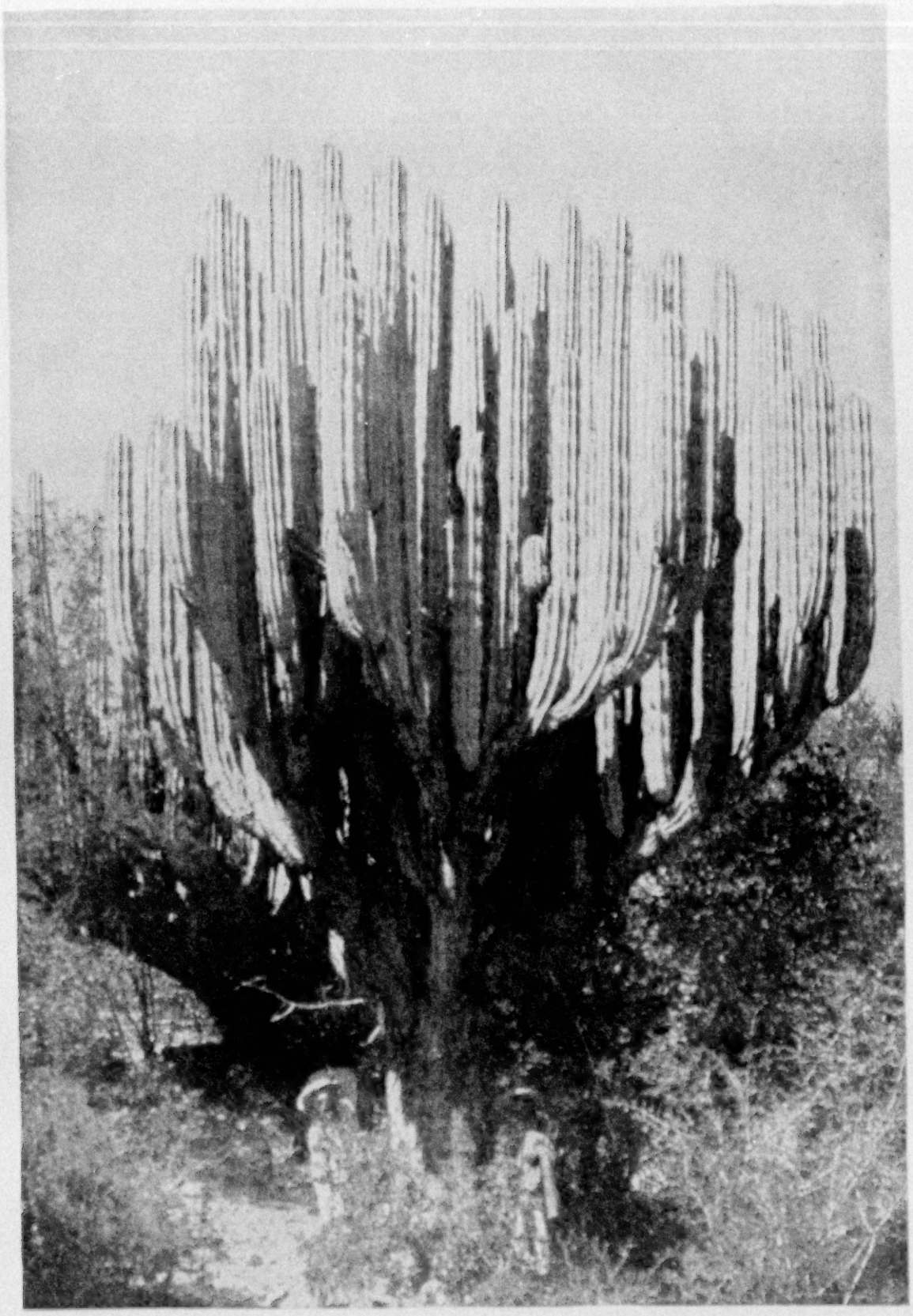
### THE SEEDS OF THE DESERT PLANTS ARE AS EXTRAORDINARY AS THEIR STORAGE ABILITY

Several species of birds make their nests in the branches of the cylindrical opuntias, where they are secure from hawks and marauding animals, and *many rodents of the desert drag the detached joints about their burrows, making an effectual barricade against the coyote and fox.*

The agaves form their great rosettes of thickened leaves on the slopes running up from the greater mesas, and after a period of development, which varies from a few to many years, a central flower-stalk is sent up in the foresummer with extraordinary rapidity, growing in length as much as a foot a day and quickly forming flowers and seeds. This effort exhausts the resources and terminates the life of the individual, and the entire cycle of these "century-plants" is directed to this one effort of arriving at mature size, with an accumulated food supply that will enable them to perfect a crop of fruits and seeds.

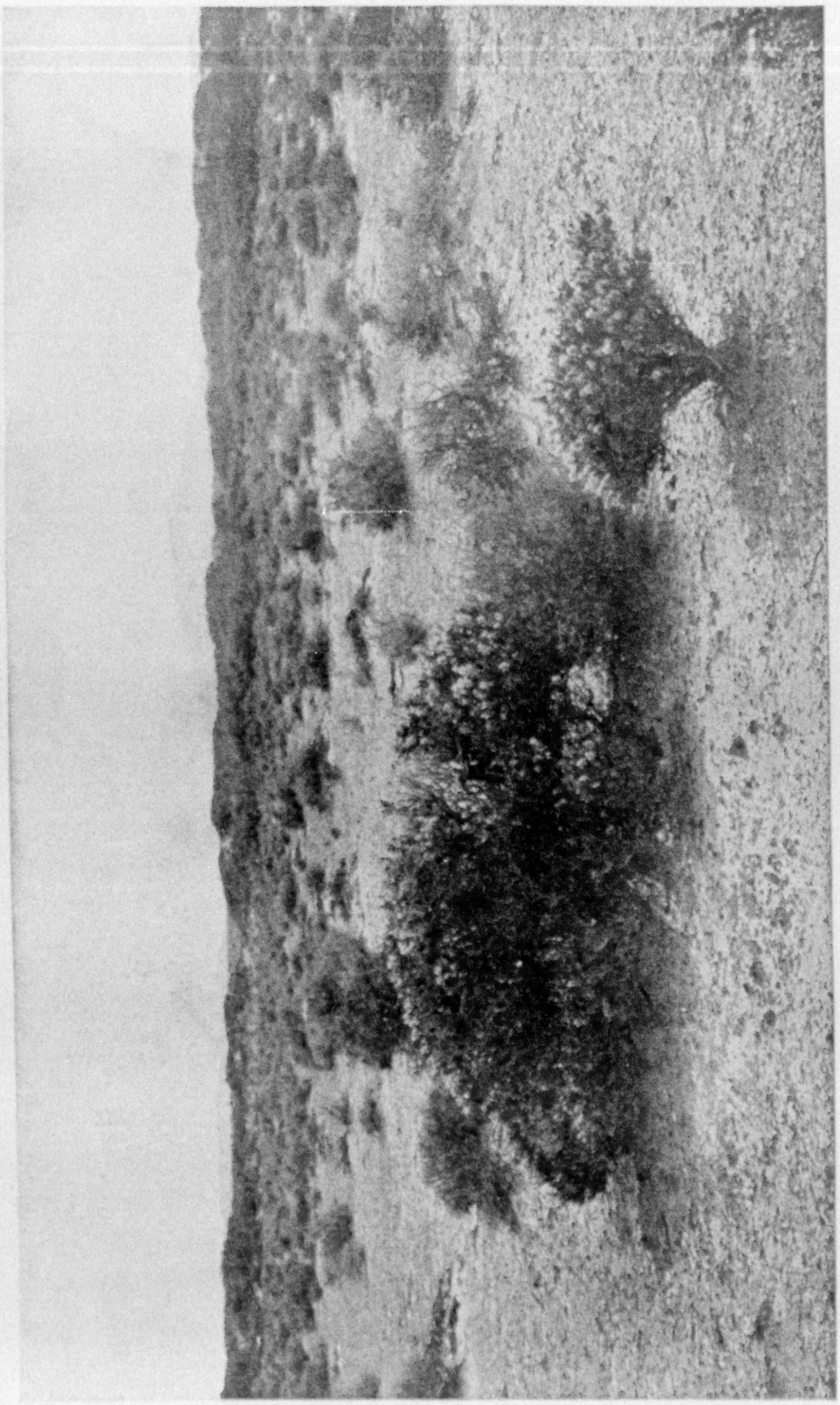
This habit makes the agaves an important source of food for the southwestern Indians, who take the rosettes when nearly mature, and, after cutting away the tips of the leaves, bake the central stem and attached leaf-bases for the sugary substances to be obtained, making what is known as mescal. The mescal-pits, used a decade ago, are numerous in the foothills of the mountains in this region, and even yet one may occasionally surprise an Indian feasting upon this prized delicacy (see page 712).

The seeds of the saguaro, which are produced in enormous quantities, are devoured by the birds before being freed from the fruits, but of the great number that reach the ground and germinate, not one in a million survives and makes the curious globular plantlet a few

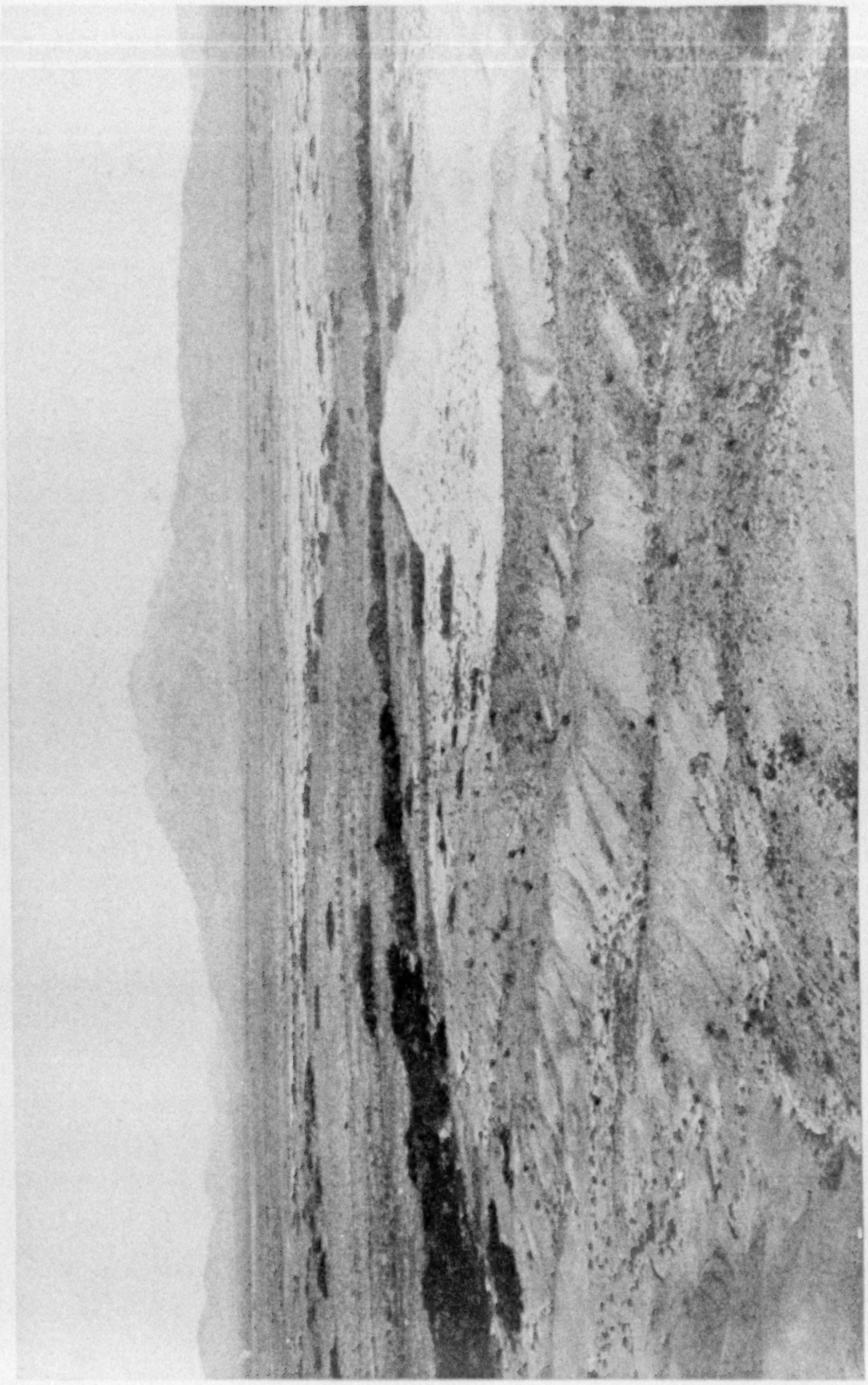


THE MOST MASSIVE OF ALL CACTI, *Cereus weberi*: TOMELLIN, MEXICO

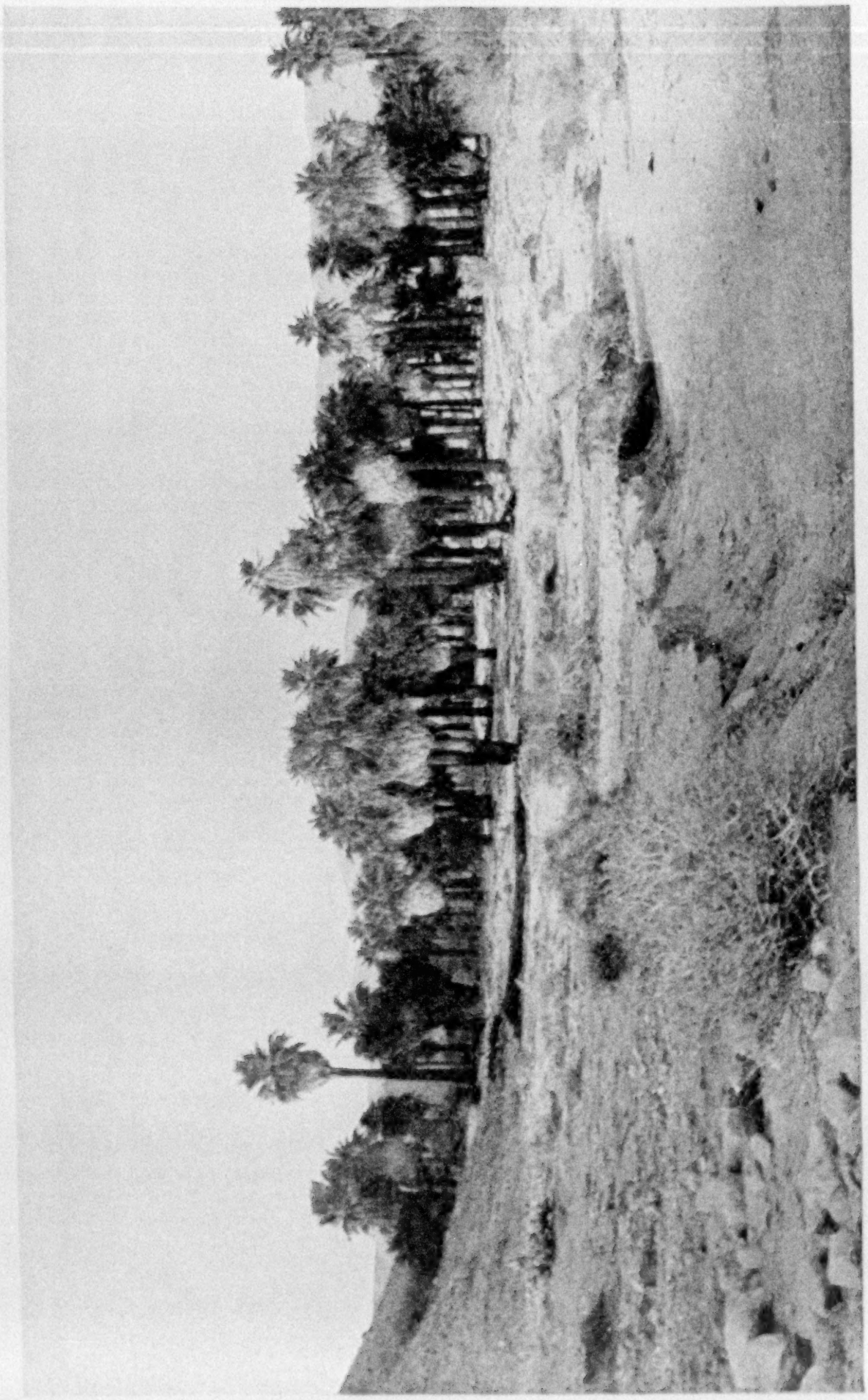
The human figures, which may be indistinctly seen at the foot of the tree, give an idea of the great size of this cactus. The numerous thick branches all arise from a central stem within a few feet of the ground.



CLUMPS OF DESERT VEGETATION NEAR LAS VEGAS, NEVADA: *Petalonyx nitidens* IN FOREGROUND



THE DESERT PLAIN OF LAS VEGAS, NEVADA, SHOWING EXPANSES OF LOOSE ALKALINE SOIL



OASIS OF PALMS (*Neowashingtonia filifera*) IN THE MOUTH OF A CANYON NEAR INDIO, COLORADO DESERT

inches in height, eventually destined to become a giant cactus. The seedlings of all the cacti form a favorite food of a large number of small animals, being juicy reservoirs of water, and containing enough other material to lead to their destruction before sufficient armament has been formed for their protection.

The seeds of the winter annuals of the Desert of Tucson show amazing endurance. Seeds are ripened and thrown on the ground in March and April. The surface layers of the soil reach a temperature of over 100° F. during the summer months. The summer rains come and soak both the soil and seeds, but still no activity is shown, and the experimentalist who attempts to use these plants during the summer will find that he might as well have sown so many pebbles in his pans.

### PORTIONS OF THE DESERT HAVE BECOME HABITABLE

Formerly the desert was held to be an uninhabitable place, but by the aid of the devices of modern civilization the requirements of life, comfort, and luxury may be transported to the most remote deserts, and large populations may carry on pursuits, such as mining, unconnected with the climate, regardless of aridity. One of the most important developments of modern agriculture is that of dry farming, in which forms of economic plants are sought which will produce crops under arid conditions, and constant and assiduous attention is being given to the development of cultural methods which will facilitate the growth of plants in deserts and conserve the soil moisture by checking evaporation. These and other individual adaptations of the human animal are of extreme interest, particularly when considered by the archeologist engaged in the study of the ancient civilization of desert peoples.*

One of the most difficult problems to solve is that of transportation in the desert, and there are extensive areas in American deserts that have not yet been systematically explored by reason of this condition.

The camel is perhaps the most extensively used of any means of transportation, and as such he has played an important part in the history of the human race in the arid regions of Asia and Africa. This animal has also come to be of great usefulness in Australia, where it was introduced in 1846, and a later importation of these animals, brought in 1860, accompanied the Burke and Wills Expedition across the continent.

In this same period efforts were made to make use of the camel in American deserts, and although the conditions were undoubtedly and still seem quite as favorable, the movement was a failure by reason of prejudice and of the organization of transport of burros, horses, and mules, already in a high state of specialization in this region. The extension of railways to tap mining regions and the usefulness of the modern motor car, as proved in the deserts of Nevada, now make any further consideration of the camel unnecessary along main lines of travel, while the solitary traveler or the small party following personal routes have available animals and supplies, so that the most economical outfit is that of horses, mules, and burros. A camel is reputed to be able to carry a load of 600 pounds with ease, but the same amount might be taken by three or four burros at a cost of original investment and maintenance only a fraction of that of the camel-train.

It is to be said, however, that a small efficient camel-train would make possible the scientific exploration of the deserts of western Sonora and of the region traversed by the Camino del Diablo with some certainty of success.

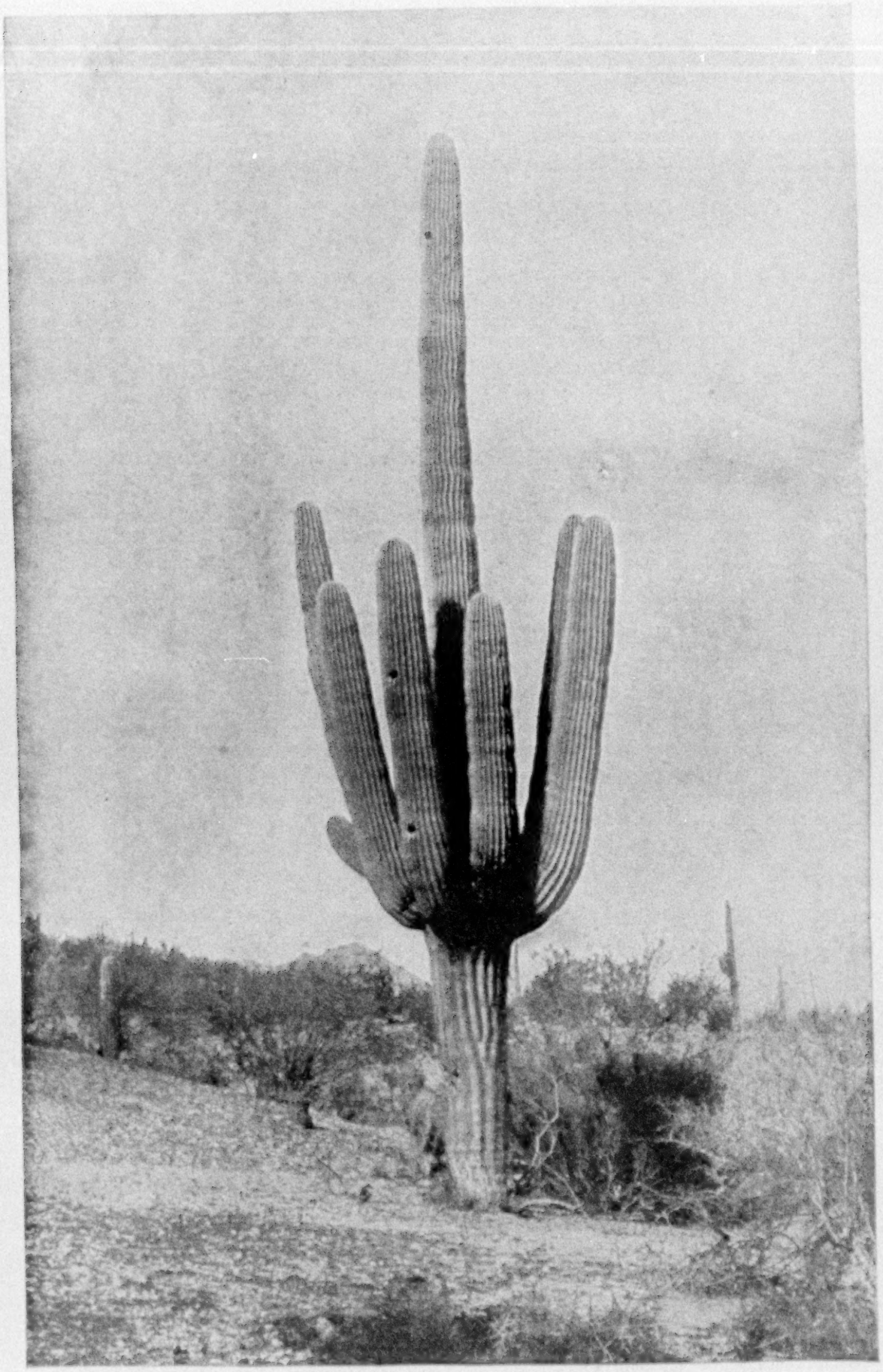
### HOW LONG CAN MAN LIVE WITHOUT WATER?

A comprehension of the part that water plays in existence and travel in the desert is to be gained only by experience.

*C. S. Scofield: Dry Farming in the Great Basin. Bulletin No. 103, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, 1907.

TWO CLOSELY RELATED PRICKLY PEARS GROWING WITH BRANCHES IN CONTACT, *Opuntia fulgida* (CHOLLA) AND *O. mamillata*

Both bear numerous maturing fruits: Tucson (see page 704)



SAGUARO, OR GIANT CACTUS (*Cereus giganteus*), NEAR MOUTH OF SALINA CANYON, SANTA CATALINA MOUNTAINS

The openings in the trunk and branches lead to large sac-shaped cavities, originally excavated by woodpeckers for nests, and afterward occupied by several other species, as well as colonies of honey-bees. This specimen is about 40 feet in height (see page 714).

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CRUSHING THE PULP OF A DECAPITATED BISNAGA (*Echinocactus*) TO OBTAIN A DRINK IN CENTRAL ARIZONA

PAPAGO INDIAN DRINKING FROM A CACTUS (*Echinocactus emoryi*) WEST OF TORRES, MEXICO

*Some of the native animals, such as mice and other small rodents, have been known to live on hard seeds without green food for periods of several months, or even as long as two or three years, and nothing in their behavior indicated that they ever took liquid in any form.**

Deer and peccary are abundant in deserts in Sonora in which the only available supply of open water is to be found in the cacti. The endurance of the camel is well known, and some of the best authenticated evidence upon the matter comes from Australia. The camels of the Tietkins party in 1891 and 1892 made a march of 537 miles in 34 days without a drink. These animals take water every day when a supply is available, but it is their capacity for accommodation that has made them such a potent factor in transportation in the deserts of Asia, Africa, and Australia. Other animals, including the common domestic sheep, are also capable of making such changes in their habits that they may go for weeks without a drink.

Man and his most constant companion on the desert in America, the horse, are comparatively poorly equipped against the rigors of the desert. A horseman may go from the morning of one day until some hour of the next in midsummer and neither he nor his horse will incur serious danger; experiences of this kind are numerous. If the traveler is afoot, abstinence from water from sunrise to sunset is a serious inconvenience to him, and if he continues his journey, the following morning his sufferings may so disturb his mental balance that he may be unable to follow a trail, and by the evening of that day, if he has not come to something drinkable, he may not recognize the friendly stream in his way. Instances are not unknown in which sufferers from thirst have forded streams waist deep to wander out on the dry plain to a grisly death.

Some estimate may be made of the actual amount necessary from the fact that a worker at the Desert Laboratory during the course of an ordinary day in May, at Tucson, consumed 16 pints of water. A horse would have used 15 or 20 gallons in the same time. A walk of 3 or 4 miles was taken, but no special muscular effort beyond this was involved. A march across the desert in midsummer would increase this quantity by half. Under such circumstances, a canteen of less capacity than a gallon is a toy, and one of real usefulness should contain at least twice that amount.

The most notable example of endurance of thirst is that of a Mexican prospector hunting for a "lost mine" near the old Camino del Diablo, or trail from Sonora to Yuma, who made camp safely after being out for eight days with a supply sufficient for one. This experience is not likely to be duplicated soon, although it is reported that Indians often go as long as four days without water.*

The experience of the field expeditions from the Desert Laboratory demonstrates that saline or alkaline waters which contain as much as one-fourth of 1 per cent of salts may be used for periods of many days without serious discomfort, but if the proportion be increased to one-third of 1 per cent only hardened travelers may use it, while water which contains as much as one-half of 1 per cent is inimical to health and comfort, although it might suffice for a few hours or save the life of a person who had been wholly without water.

All devices for allaying the discomfort arising from the dryness of the mucous membrane, such as carrying bullets or pebbles in the mouth, chewing grass or a piece of rubber, are wholly futile in meeting the serious thirst problem. The relative humidity often falls to 5 per cent in the Southwestern deserts, and in a temperature of over 100° the evaporation from a vessel of water standing in the open may be as much as an inch a day. The amount thrown off by the skin is correspondingly great, and if the loss is

*F. V. Coville: Desert Plants as a Source of Drinking Water. Smithsonian Reports for 1903, pp. 499-505.

*W J McGee: Desert Thirst as a Disease. Interstate Medical Journal, vol. 13, No. 3, 1906.

XUM

not made good, thirst ensues, and ten hours' lack of water may thicken the tongue so that speech is impossible.

### THE BARREL CACTUS

The Indian and the desert traveler often seek relief in the juices of plants when water fails. The fruits of some of the prickly-pears are slightly juicy, the stems of the same plant or the great trunks of the saguaro contain much sap, but for the most part it is bitter, and while it would save life, in extremity, yet it is very unpleasant to use.

The barrel cactus, or bisnaga (*Echinocactus*), however, contains within its great spiny cylinders a fair substitute for good water. To get at this easily one must be armed with a stout knife or an ax with which to decapitate the plant, which is done by cutting away a section from the top. Lacking a suitable tool, the thirsty traveler may burn the spines from the outside of the bisnaga by applying a lighted match, and then crush the top with a heavy stone. This or other means is taken to remove a section 6 to 8 inches in thickness. Next a green stake is obtained from some shrub or tree that is free from bitter substances, and with this or with the ax the white tissue of the interior is pounded to a pulp and a cavity that would hold two gallons is formed. Squeezing the pulp between the hands into this cavity will give from 3 to 6 pints of a drinkable liquid that is far from unpleasant and is generally a few degrees cooler than the air.

Scouting Indians have long used the bisnaga, and a drink may be obtained in this manner by a skilled operator in 5 to 10 minutes. Some travelers are inclined to look with much disfavor on the liquid so obtained, but it has been used without discomfort by members of expeditions from the Desert Laboratory. That it is often preferred by Indians to fair water is evinced by the fact that the Whipple Expedition found the Mohaves near the mouth of the Bill Williams River, in 1853, cooking ducks and other birds in the juice of these plants by means of heated stones dropped into the cavity containing the pulp.

The sap of the saguaro (*Cereus giganteus*) and of other cacti contains bitter substances that make it impossible to be used to allay thirst by man, although it may be given to burros. A supply is usually obtained by felling the heavy trunk and elevating the ends a few inches above the ground, while the middle is allowed to sag lower over a bucket or vessel that has been suitably placed in a hole in the ground below. A cut is made above the bucket to allow the liquid to escape, while the process is hastened somewhat by building a fire under the ends.

The experiences of the expeditions from the Desert Laboratory made it evident that a still or condenser, by which even a small quantity of drinkable water could be obtained from the abundant sap of these plants or from alkaline waters, would greatly facilitate field-work. After some experiment, one was designed by Mr Godfrey Sykes, in which the cactus pulp or liquid to be distilled is placed in a boiler of pressed steel. This apparatus is now used by the laboratory parties while at work in the deserts. It has a capacity of several gallons per day, which enables a party to make an extended stay at a locality where the untreated water is undrinkable.

# CAMP FIRES ON DESERT AND LAVA*

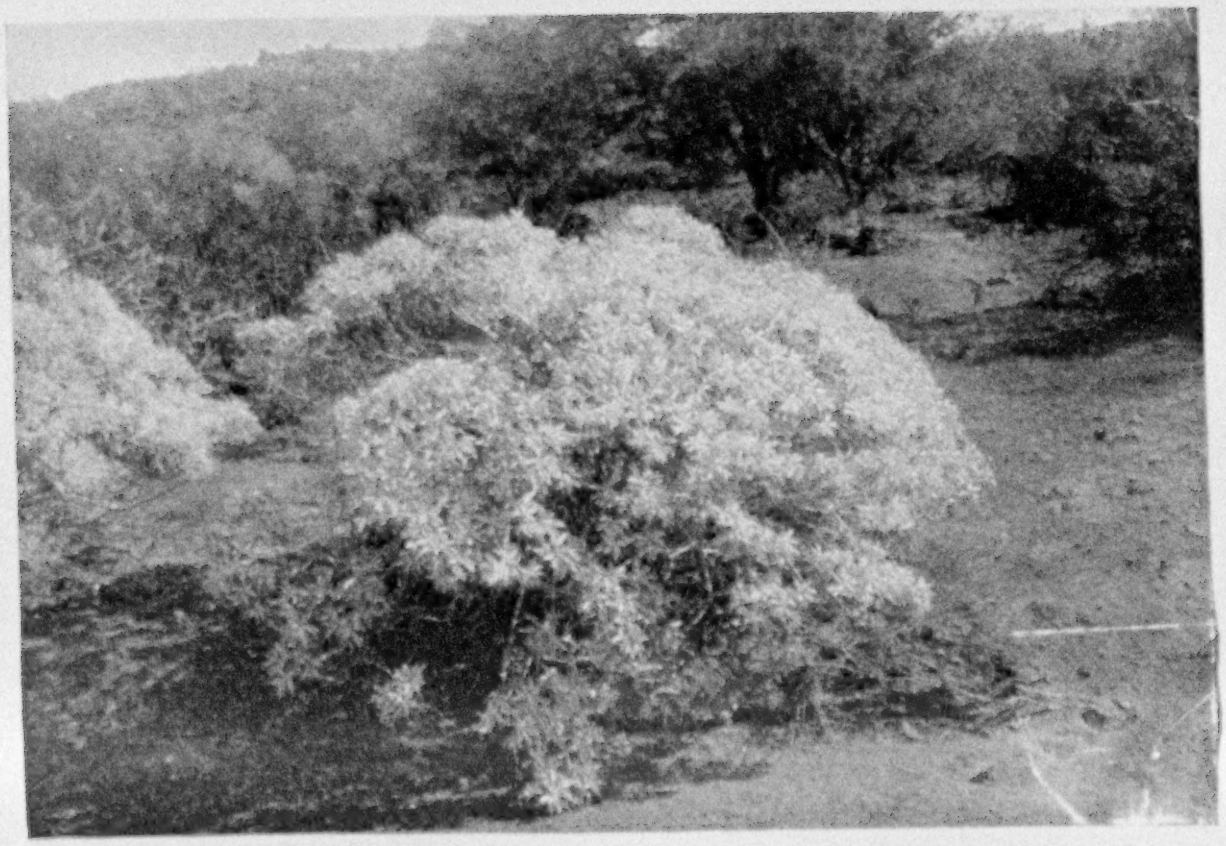
THE expedition described in this most valuable book was an exploration of a genuine terra incognita, for while it is true that the Pinacate region, lying in the northwestern corner of Mexico, or, broadly speaking, in the Sonoran Desert between Tucson, Arizona, and the Gulf of California, was known to a few Papago Indians and several Mexicans, it was totally unknown to the outside world. There was no information whatever about this region, and on all available maps the space around the Pinacate dot was an absolute blank.

Naturally, the animal and plant life of the Pinacate region was as much unknown as its geography; hence the value of the results obtained to the botanist, zoölogist, sportsman, and geographer.

Mr Hornaday tells in a graphic way of the wonders of the desert region, of extinct volcanoes, the marvelous desert botanical gardens, and of hunting mountain sheep in the lava, together with chapters of absorbing interest on the legend and history of that country, the book being splendidly illustrated with photographs of the expedition.

Describing the desert vegetation, the author says: The White Brittle-bush, as seen standing alone on bare black lava, is truly a thing of beauty. It is hemispherical, symmetrical, immaculate, and clean as a new shirt. It is a big white bouquet. Its leaves are all on the outside, and although its branches are large and stocky—for the storage of water—they are so brittle that you can grasp a great handful of the outer stems and, with one movement, snap off every one of them as if they were so many pipe-stems of clay. The leaves are very large—for a desert plant—the blade being shaped like a broad arrow-head, one and one-half inches long by one and one-quarter wide. The flower is a little yellow composite, like a tiny yellow daisy, thrust far up on the tip of a frail and friable little flower-stalk six inches

* "Camp Fires on Desert and Lava." By Wm. T. Hornaday, Sc. D., pp. 366, 50 illustrations, 8 in colors. Charles Scribner Sons: New York. $3.30 postpaid.



THE WHITE BRITTLE-BUSH

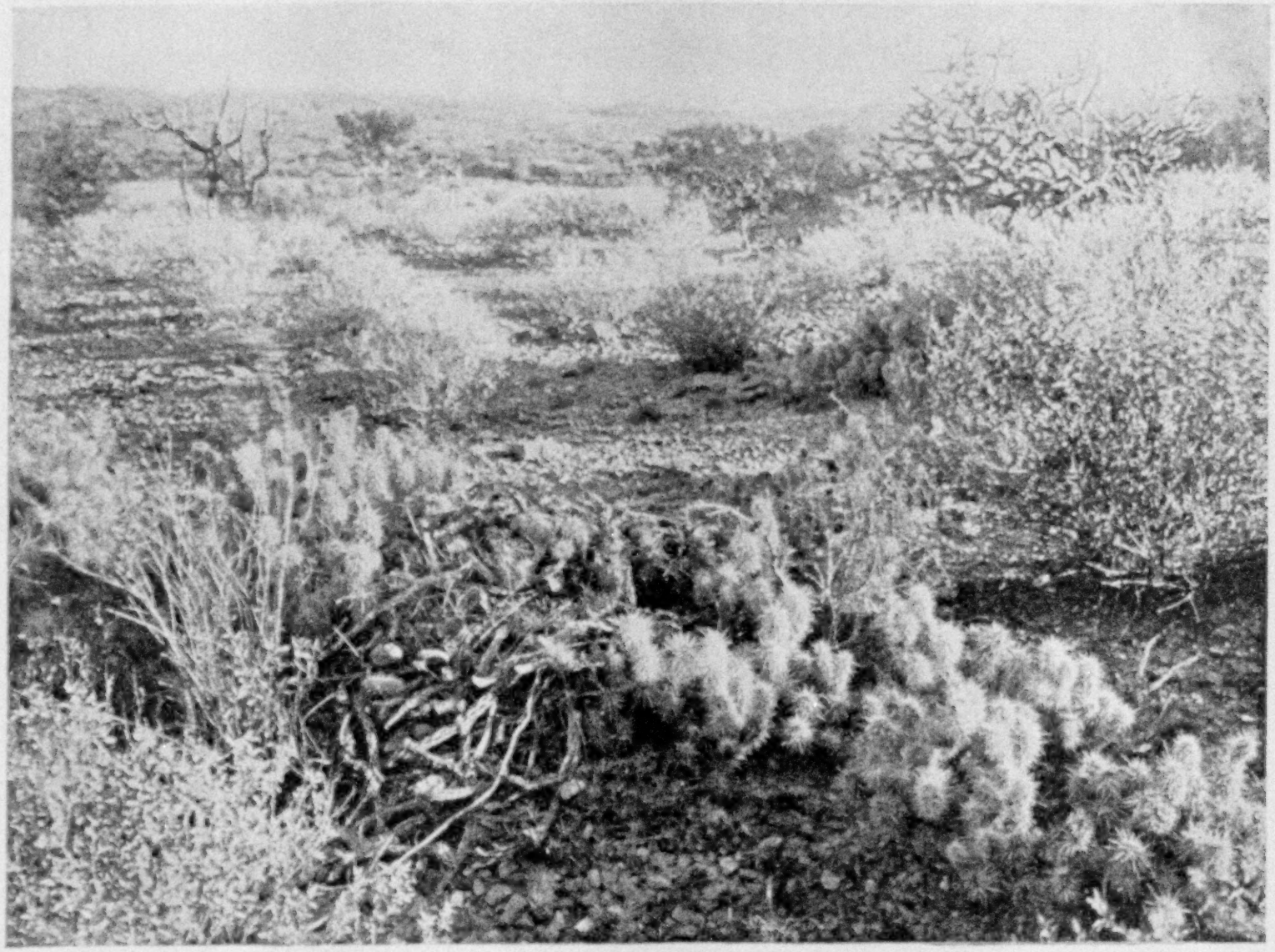
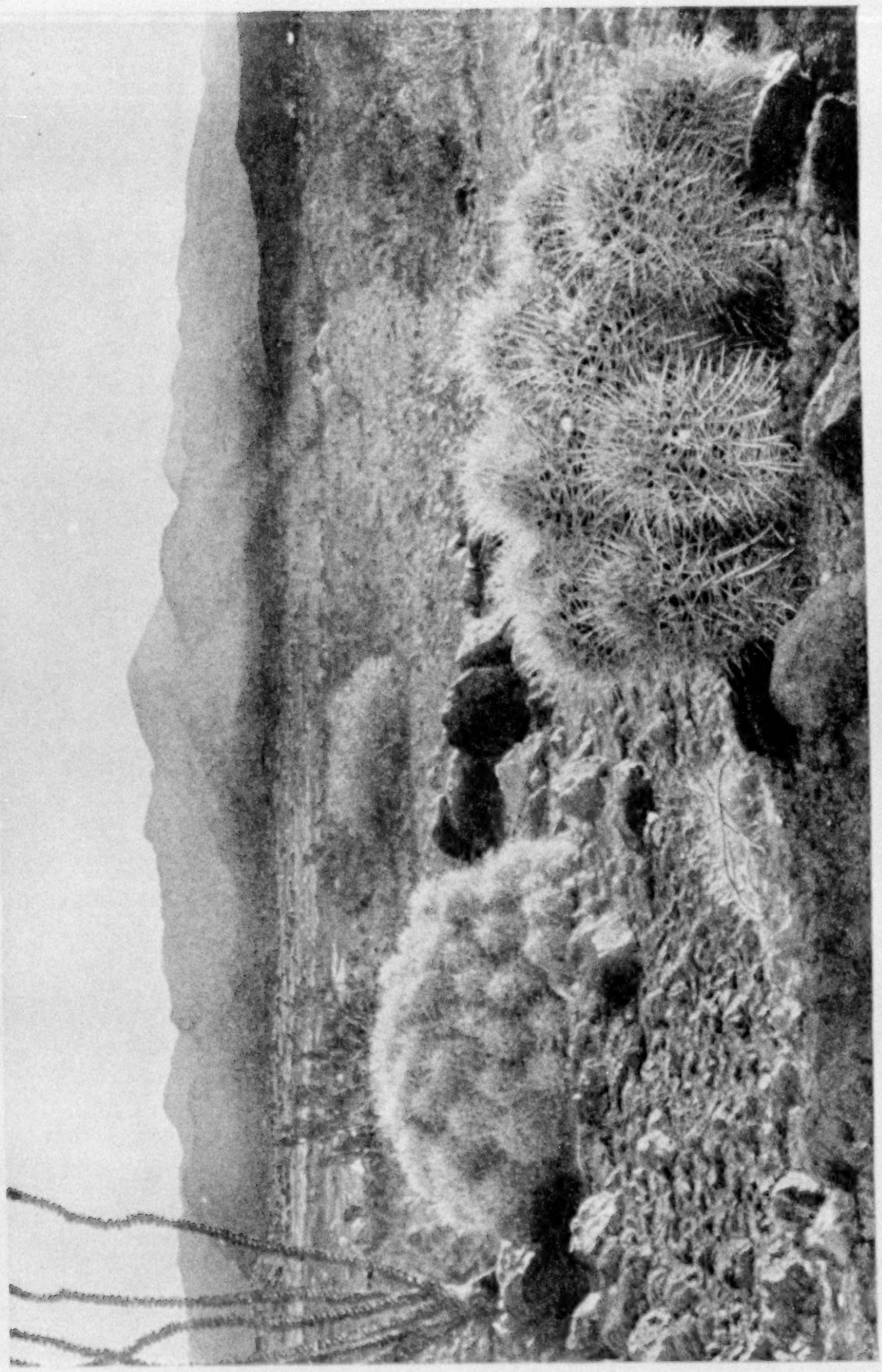


Photo from D. T. MacDougal

DETAILS OF TYPICAL DESERT VEGETATION ON HILLTOP AT SANTO DOMINGO

Pack-Rats' nest; a new species of cactus—*Opuntia kunzei;* creosote bushes; skeleton of a dead tree, *choya,* in left middle distance; two white cottonwoods in distance, near river; and in upper right corner an *Opuntia versicolor*



VIEW OF PINACATE ACROSS THE LAVA FIELD, FROM THE TULE TANK

higher than the periphery of the foliage. We found few of them in flower, but enough for our inquisitive purpose. To the taste, the foliage is strongly aromatic, pungent, and bitter, and recalls the foliage of the common sage-brush (Artemisia). Apparently no animal eats the stems or foliage of the White Brittle-bush, and we are very glad of it, for it is truly a soft and pleasing thing to contemplate on the scowling lava-fields. The mountain sheep doubtless shared our views, since nearly every one killed was found to have browsed amply on the slender, delicate dead flower-stalks of the last season that still adhered to the stems and projected above the grayish-green mass. This bush is said to be widespread in the southwestern desert, but I did not notice it anywhere outside the Pinacate-Sonovta region, which may have been my fault.

Naturally, in such a wild and weird spot as the Pinacate region, every plant, tree, and living creature is of interest—rendered so by the grim surroundings and the intensity of the struggle to survive. It is fair to assume that the plant life we saw at the Papago Tanks represents only the bolder and hardiest species of the southwestern desert region, because were they otherwise they assuredly would not be there.

## BOOK REVIEWS

*Physical and Commercial Geography.* By H. E. Gregory, A. G. Keller, and A. L. Bishop. Pp. 8 and 469, 9 x 6. Boston: Ginn & Co. 1910.

Most commercial geographies contain more or less physical geography, since without a knowledge of the physical environment no adequate study of the economic condition of a country can be made. But this is, we believe, the first commercial geography which has included the word "physical" in its title. The book is in three parts, the different parts having been prepared by the authors severally. They are as follows: (1) A description of the natural environment, physical geography, to which is devoted 123 pages; (2) the relations of man to this environment, to which is given an equal amount; (3) the products, industries, and commerce of the United States and the British and the German Empires absorb the remainder of the book.

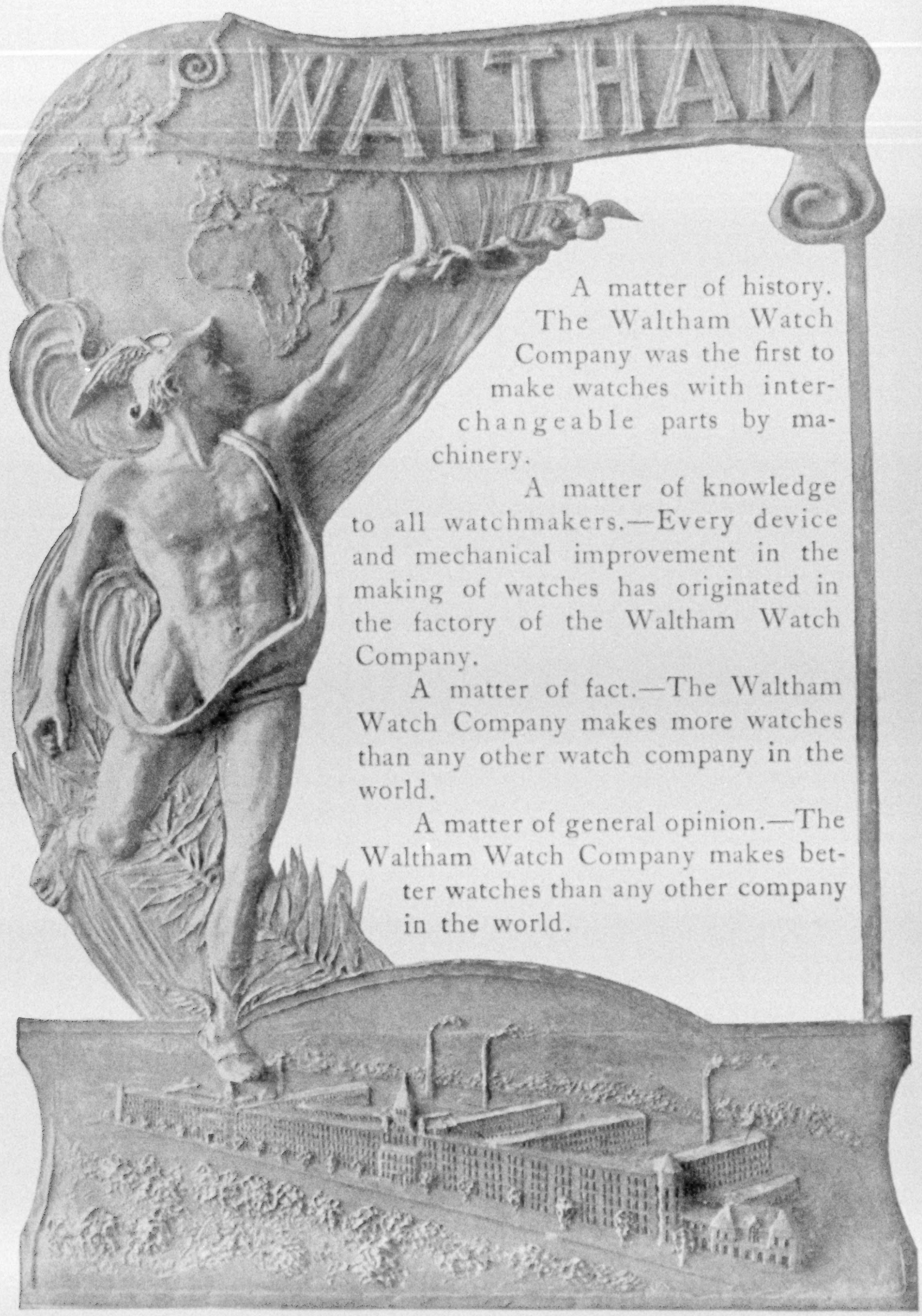
This book more nearly meets the need for a text-book on its subject than any of its predecessors. Most of the works on commercial geography are, because of their fullness of detail, rather books of reference than text-books. This one treats few commodities, but representative ones, and few countries, but those the leading commercial countries. Special importance is given to the relations of man to his environment, the climate, fauna, flora, topography, water, etc., and his adaptability to changes in it. Means and routes of transportation and their development are discussed, and the increase of trade with increasing civilization. The book is illustrated with twenty-nine maps and diagrams. H. G.

*Beyond the Mexican Sierras.* By Dillon Wallace. Pp. 35 and 301, 5½ x 8. Chicago: A. C. McClurg & Co. 1910. Price, $2.00.

This is a narrative of journeyings in a little-known land, southwestern Mexico. The story is graphic and full of interest. The illustrations are abundant and excellent. Here is a region comprising many thousands of square miles very sparsely populated with Indians and full of big game; a region of the greatest agricultural and mining possibilities, lying undeveloped at our own doors. H. G.

*The Indian and His Problem.* By Francis E. Leupp. Pp. 14 and 369, 5½ x 8. New York: Charles Scribner's Sons. 1910.

The best book on the Indian that was ever printed. Mr. Leupp writes with fullness of knowledge of the characters of the Indians, of their history, and of the conditions which surround them. He thoroughly believes in the policy now in execution of making citizens of the Indians as rapidly as possible, consistent with their well-being. It is much to be regretted that Mr. Leupp could not have remained at the head of the Indian Office until this and other reforms with which he was identified could have been completed. H. G.

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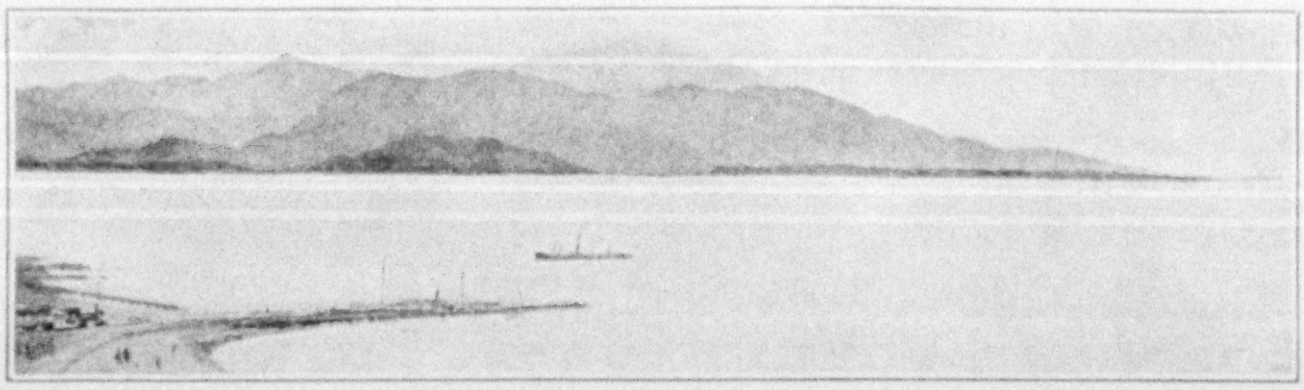

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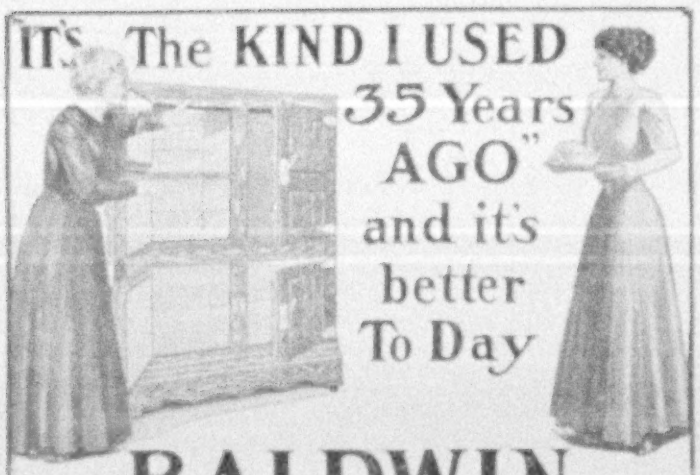

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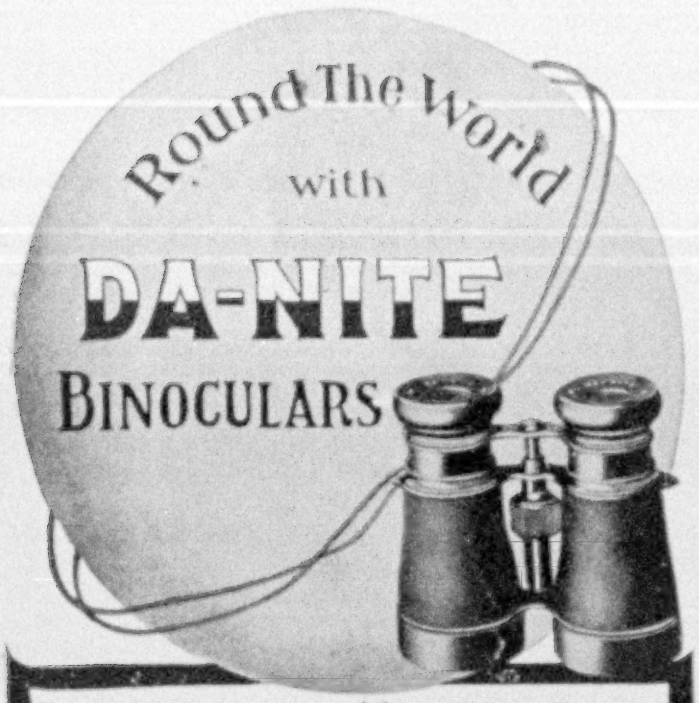


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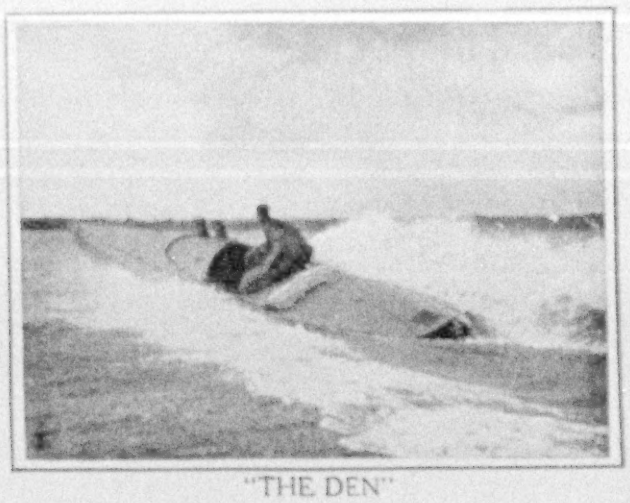

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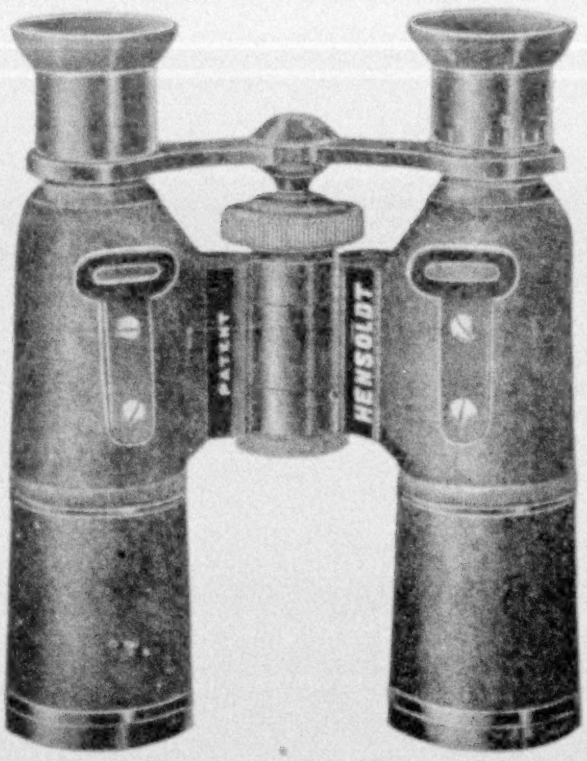


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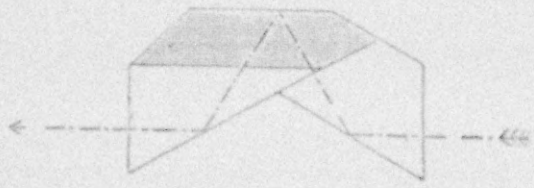

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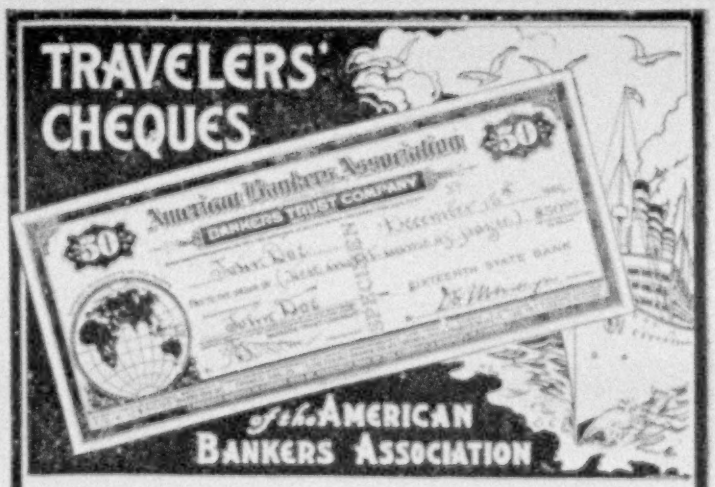


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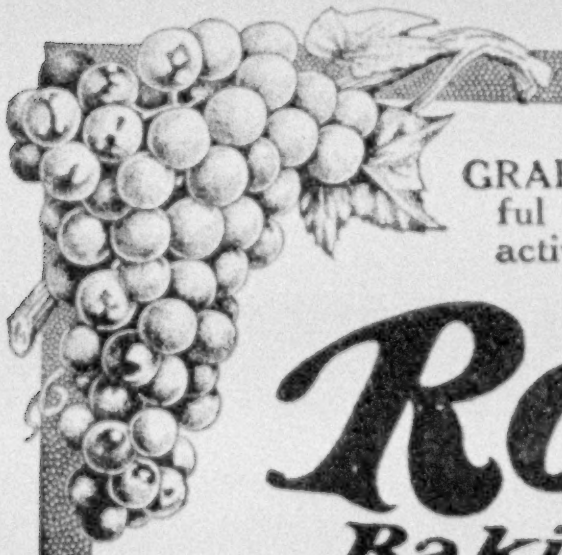

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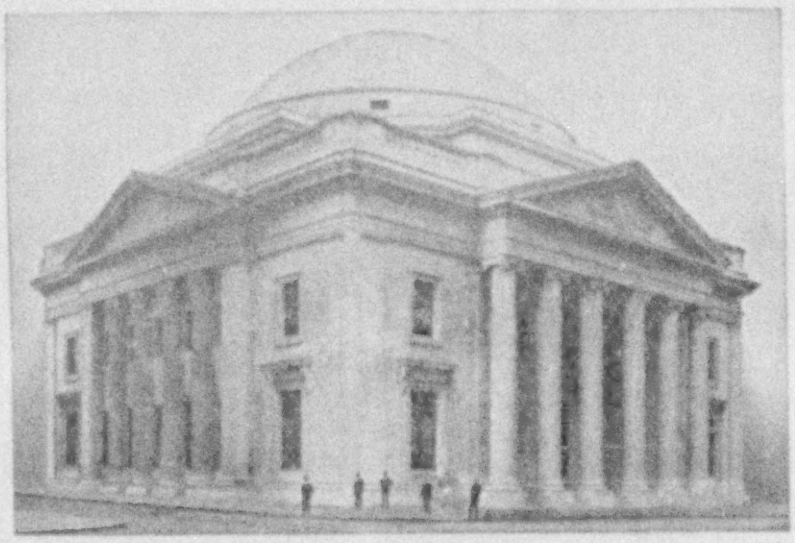

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